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THE ANALYTIC SCIENCES CORPORATION

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USER NEEDS ASSESSMENT FOR THE USDA FOREST SERVICE WEATHER INFORMATION MANAGEMENT SYSTEM (WIMS)

5 March 1988

Prepared for:

USDA FOREST SERVICE

Prepared by:
Arthur Bass
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Approved by:
Paul Janota

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Reading, Massachusetts 01867

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1. INTRODUCTION

The USDA Forest Service needs a fundamentally new system to manage forestry weather information nationwide in the 1990s. The Forest Service´s current system, the Administrative Forest Fire Information Retrieval and Management System (AFFIRMS) and the National Fire Weather Data Library (NFWDL), was designed in the 1970s to satisfy a narrow set of fire management needs. AFFIRMS has been costly to use, (at least until very recently), difficult to learn, slow and awkward. It does not offer many human interface and processing functions that are now standard features of a modern information management system. It does not (for example) provide even rudimentary tools for graphic display or interactive data management.

Fire management specialists within and without the Forest Service have come to view the AFFIRMS service as very expensive for the limited capabilities it provides. As a consequence AFFIRMS may be losing its customer base in the long term.

AFFIRMS is obsolete relative to today´s needs for forestry weather information management across the Forest Service´s many program areas. Because it focuses narrowly only on fire management, AFFIRMS cannot reach out to attract new non-fire users of weather data and information. It doesn´t offer a broad range of products and applications that would make weather information available for decision making in other Forest Service program areas.

For all these reasons, the Forest Service has begun the process of developing and implementing a new, comprehensive system for its forestry weather information management needs. The new system, to be called the Weather Information Management System (or WIMS), will be designed specifically to accommodate the information management skills and decision needs of forestry weather information users throughout the nation's forestry and land management communities. The Forest Service's intent is to attract the largest possible customer base for WIMS, by providing timely access to many sources of weather data and related information; effective data management, processing and display in a supportive user environment; and access to modern data storage and data communication facilities.

In July 1987 the USDA Forest Service took the first step toward the acquisition of a comprehensive WIMS with the award of a study contract (to The Analytic Sciences Corporation) for Analysis of Forestry Weather Information Needs and Delivery Systems. The study will be carried out in four Tasks:

- Task 1 -- A thorough User Needs Assessment to define and scope requirements for a system to meet the current and foreseeable needs for managing forestry weather data and related information;
- Task 2 -- A detailed assessment of minimum system performance requirements for a new WIMS;
- Task 3 -- A tradeoff analysis of alternative conceptual system architectures for WIMS;
- Task 4 -- A System Requirements Specification for the selected system design

Task 1, the comprehensive User Needs Assessment, was carried out in the fall of 1987, by interviewing (in person or by telephone) 157 of the nation's actual or prospective users of forestry weather information. The interviews included a sizable number of the Forest Service's most knowledgeable users of fire/forestry weather, but also included many others who perceive weather to be of less significance to the program area activities they support. In addition, representatives of weather users from the principal Federal land management agencies and five states were included.

The purpose of these interviews was to develop a broadly representative and candid composite picture of:

- How, where, when and why forestry weather information is actually acquired and used throughout the Forest Service and other Federal and state land management agencies
- How Forest Service personnel and other members of the fire/ forestry community now perceive the influences of weather and weather-related phenomena on operational decisions
- How they perceive the benefits and decision value of weather information, and their willingness to pay for such information
- What other forestry weather users (e.g., the BLM, NPS and states) are doing to acquire fire/forestry weather data and information management capabilities and services.
- How the design and development of WIMS might take into account the weather needs, capabilities and system development plans of these other groups, in order to achieve the Forest Service's goal to increase the use of WIMS services by a broader forestry

community and by other Federal and State cooperators.

This report documents the results of Task 1, the comprehensive User Needs Assessment. Successive sections discuss in detail:

- The approaches for selecting interviewees, interviewing, collecting and interpreting the information
- The weather information/management needs and requirements identified by users
- The partitioning of these needs into specific program areas
- Our interpretations and principal conclusions about stated user needs for WIMS and
- Important issues for resolution.

2. STUDY METHODOLOGY FOR THE WIMS USER NEEDS ASSESSMENT

2.1 BASIC TECHNICAL APPROACH

The overall objective of Task 1 was to identify and scope the requirements for WIMS, by means of a detailed user needs assessment of Service-wide, Regional and local requirements for meteorological and climatological information in the Forest Service. The intent was to learn how potential users of WIMS actually use and manage weather information (or would want to), and whether they perceive their weather information needs realistically, in terms of feasibility, utility, decision value, costs versus benefits, and willingness to pay. Where possible, therefore, the following information was gathered from potential users:

- Needs for weather data and weather-related information products, including: sources, types, amounts, formats or delivery modes, details or resolutions, representativeness, reliability and timeliness
- Needs for a modern weather information management environment, including: high-level capabilities of the WIMS workstation and human interface; and needs for data/product acquisition and quality control, data processing algorithms and models, data/product/report generation, distribution, storage and archive, and communications
- Needs for system support, including: network communications, interfaces to external systems, and national-scale data/product archive

- User understanding of the sensitivity, value, and costs vs. benefits of weather information for operational decisions; and user willingness/ability to pay for these data, information products, and system capabilities

Previous Forest Service surveys, (both nationwide and regional in scope), have explored some of these issues, primarily in the context of needed upgrades to AFFIRMS. These surveys were carried out by mailing formal written questionnaires to a wide population. The results have been useful but limited. This is not surprising, because a questionnaire must, in effect, anticipate all subjects to be explored and bound the range of possible responses. So we are unlikely to learn something entirely new or unexpected from the responses. Moreover, many people are uncomfortable about responding in writing to a formal questionnaire from their own employer (especially if they cannot be assured of anonymity), so true feelings tend to be suppressed.

A far more preferable approach is to gather such information by interviews, face-to-face wherever feasible, and by telephone otherwise. A personal interview in the interviewees' work setting provides a casual, comfortable format. The interviewee can show us how he uses a workstation, and quickly display for us the various kinds of weather data and information products (e.g. tables, graphs, maps, imagery) that are important to him. An interview setting provides the interviewer with opportunities to digress from the stated agenda in order to explore related subjects and side questions. Such digressions are often unexpectedly valuable -- sometimes much more so than the interview agenda itself -- in terms of the interviewee's interest, knowledge, and willingness to respond. Although interviews are time consuming and costly to carry out, they can be highly productive when respondents are interested, are knowledgeable and able to speak for the organization, are informed well in advance about the nature and purpose of the interview, and are available and prepared to respond.

2.2 INTERVIEWEES

With some suggestions from TASC, the Forest Service COTR designated a long list of target interviewees, some for personal visits wherever possible, and others for telephone interviews. Interviewees were selected as potential WIMS users, that is, managers and technical specialists knowledgeable about or interested in the uses and decision value of weather information. The list was drawn largely from the Forest Service's operational and research staffs nationwide, but also included fire-weather specialists from the National Weather Service (NWS), the Bureau of Land Management (BLM), the National Park Service (NPS), the Fish and Wildlife Service (FWS), the Bureau of Indian Affairs (BIA), and five State agencies. The overall geographic coverage was excellent.

To introduce the study the COTR's office prepared and distributed a letter of transmittal, together with a summary of an interview guide prepared by TASC. With the timely cooperation of the Forest Service Washington, DC office (FS/WO) staff, this pre-visit information package was sent to all the offices at which visits/telephone contacts were planned.

Unfortunately, the late summer-early fall timing of the visit schedule ran headlong into an extraordinarily severe fire season nationwide. Numerous senior Forest Service personnel were unavailable for scheduled interviews, or were called away from the office at the very last moment. Also in several instances the press of urgent fire business at a Regional Office prevented timely distribution of information about this study to the staff specialists, so we arrived to find that interviewees had minimal prior knowledge of the study and, in particular, had not seen the preliminary interview materials which were prepared to familiarize them in advance with the purpose and scope of our forthcoming visits.

Nevertheless, with excellent liaison support from the COTR and WO staff, in most cases we were able to identify substitute interviewees, to brief them quickly on the overall objectives and bounds for our information-gathering mission, and to conduct the interviews. In all, we visited with, or spoke at length by telephone to, more than 150 respondents. Appendix A contains a complete list of all those actually interviewed, arranged by agency/organizational affiliation, functional area, name and title (where known to us).

2.3 INTERVIEW GUIDE

The real value of an exploratory ´user needs´ interview (in terms of substantial, candid information actually obtained) depends in good measure upon the interviewer´s skill. The discussion should appear to flow effortlessly according to the user´s particular interests and concerns. At the same time, the interviewer must keep the basic objectives and topics in tight focus. When used unobtrusively, an Interview Guide is a good tool for this purpose.

Appendix B reproduces the full multipage Interview Guide we developed for the user needs assessment. It begins with a number of high-level overview questions to steer the overall conversation. To open the discussion we would typically ask such questions as, "What job do you do and how do you do it? What data/information is input to each function? Who are the users of the information products you create? What are the timelines and other operational constraints on how you do each function? What are the primary tasks and subtasks of this office today?".

Then the Guide proceeds in successive levels of detail to explore: the user′s perceived needs, actual uses, and operational decisions with weather information; the user′s ability to exploit modern computer-based weather information management tools; the user′s recognition of and willingness to pay for the costs vs. benefits of weather information and its management.

As can be seen in Appendix B, the questions are carefully arranged in groups with levels of increasing specificity, so that it is easy to move from one topic area to another whenever a interviewee′s knowledge or resistance level is exceeded. A rich set of general questions is directed to all interviewees.

In addition, special groups of questions are directed at specific classes of respondents, e.g.: current or past users of AFFIRMS; current or past users of FWIS; non-users of automated weather information; and fire weather forecasters. Overall, the Interview Guide served us very well in dealing with a broad spectrum of interviewee knowledge about and interest in weather information and its management.

2.4 INFORMATION COLLECTION AND ANALYSIS

Most of the detailed face-to-face interviews were conducted by pairs of team members. Interviewees known to be knowledgeable, ´active´ users of weather information were usually interviewed individually, typically for 60 minutes or more each. (In some few instances, logistics forced us to interview some users in small groups.)

When approached to set up interview appointments, however, a fairly large subset of interviewees indicated only marginal interest in the study. Many felt they had little useful information to share with us. Others indicated they were only marginally knowledgeable about weather and its decision value. For efficiency in talking about weather information needs to these ´passive´ but potential users of WIMS, we conducted some of the personal interviews in groups of two or three. To maintain consistency and overall insight into the diverse needs of the Forest Service, the same team member conducted all of the telephone interviews.

Interviewees were encouraged to speak frankly about their current weather information resources, and their primary WIMS needs. They were assured that their individual comments would not be specifically attributed, but used only as aggregated with all the others. At the same time, we took pains to point out that we would not necessarily include every need identified by a user. We tried to make clear that our analysis of the overall ´envelope´ of WIMS needs would address the priority concerns and realistic needs of most users.

Each interview resulted in a set of handwritten notes, some very extensive. All the interview notes were transcribed electronically and distributed to all the team members. In every case, two or more team members reviewed each set of interview notes, to extract the `raw´ needs (as we called them) stated by each respondent.

The `raw´ needs were then grouped, without reference to origin, into (a) needs that appear to `belong´ primarily to one or another major Forest Service program activity area, and (b) needs that seem sufficiently common or broad-based `general system needs´ (for example, the ability to exchange data easily with certain non-Forest Service external systems). The following groupings were used:

- General System Needs
- Fire and Aviation Management Needs
- Air Resource Management Needs
- Watershed/Hydrology Needs
- Range Management Needs
- Timber Management Needs
- Pest Management Needs
- Recreation Needs
- Engineering Needs
- Fisheries and Wildlife Needs
- Forestry Weather Forecast Services Needs

The next step was to `edit´ each group of needs to eliminate obviously redundant or substantially similar needs stated by different respondents and agencies; and unrealistic or naive needs (e.g., requests for accurate five year precipitation forecasts). The resulting sets of 'edited' needs are reproduced as Appendices C1-C10.

2.5 NEEDS INTERPRETATION AND PRIORITIZATION

In arranging and describing these needs (for Section 3 following) we could not entirely avoid some subjective prioritization, especially because some of the stated needs appear marginal. Only a small fraction of those interviewed have thought about the decision value of weather information. None of the interviewees had a procedure for assigning dollar measures of benefit vs. cost for weather information. All were reluctant to speculate for the record about so important an issue. It is a fair conclusion that a large majority of potential users of WIMS do not know how to quantify, relative to their own applications, the decision-value or benefit vs. cost of weather information and management. Moreover, those interviewed were not prepared to indicate at this time their 'willingness to pay' for WIMS services and products (see discussion in Section 4.4).

Because we could not use 'willingness to pay' as a way to eliminate needs, we have documented here all user-identified needs that appear to meet each of the following criteria:

- The need appears to have a valid technical or operational rationale
- The solution to the need appears to be technically feasible today, or with technology that is expected to become available within the system lifetime of WIMS
- The need is not so speculative or open-ended as to be unboundable in cost.

2.6 FIRE & ATMOSPHERIC SCIENCES RESEARCH AND DEVELOPMENT ACTIVITIES: IMPLICATIONS FOR WIMS DESIGN

In planning for a 1991 time frame for implementation of WIMS, we must decide which new (or modified) technologies can be successfuly operational in this time frame. We also have to identify other research and development activities that are not yet ready for implementation, but may lead to operational tools or features for future WIMS updates. To get a view into the near future of fire management technology, we interviewed 18 Forest Service research leaders and scientists at five locations. The following are some highlights of what we learned. (The bulk of the information acquired from these interviews has been integrated into Section 3 as well.)

2.6.1 Intermountain Fire Sciences Laboratory, Missoula, Montana

Much of what will be produced by the Laboratory during the next 18 months should be considered for the 1991 WIMS. The following are highlights of our discussions with Fire Research staff at the Laboratory:

- Version 4.0 of BEHAVE will be released before the end of 1988. (This will be the final version of BEHAVE) The FIRE II module will be incorporated. The code is being completely overhauled. A version will produced in MS-DOS format.
- A program called WINDOWS will be completed and available for release by the end of 1988. WINDOWS asks the user to specify acceptable fire behavior characteristics. It solves the fire model algorithms "backward" to provide a table of alternative combinations of wind, temperature, and fuel moistures that will produce those fire characteristics. WINDOWS will be a

companion program to RXBURN and RXWEATHER.

- The Fire-Danger Rating System testing and verification program will be finished by the middle of 1989. This program will require access to the NFWDL and the NFODL at FCCC.
- The staff at the Intermountain Fire Sciences Laboratory felt that WIMS should
  - Include NFDRS
  - Provide easy access to NFWDL and NFODL
  - Provide easy access to (or include) BEHAVE and FIRECAST, FIREFAMILY,WINDOW, RXWEATHER, RXBURN, and the NFDRS verification program
  - Include a large fire growth model (the NPS is moving ahead with a large fire growth simulation model)
  - Include a standard query language (SQL)

Another potential feature worth considering for WIMS is access to FIREBASE, the fire literature database, and to the BLM Fire Effects database. The future of FIREBASE is not clear -- it has been taken offline. The prototype Fire Effects database, which contains fire effects information on more than 100 species of plants, is resident on the BLM Data General system at Boise.

The research staff at the Intermountain Fire Sciences Laboratory is presently planning their multi-year program to develop the integrated "second generation" fire management technology. This planning process will be completed in 1988. (In the meantime, however, much remains to be decided, and these uncertainties must concern the WIMS system designers -- see Section 4.)

Considerable progress has been made in the development of the second generation fire spread model. The most significant thing for the WIMS designers to know is that the model outputs (and perhaps many of the inputs) will be in the form of distributions.

The staff foresee GIS as the most likely data management and display format for the new integrated fire management technology. The transition to GIS will not happen overnight, however -- the agencies have only a limited understanding of the rapidly evolving GIS technology, and a Service-wide, ´corporate´ standard for geographic information systems is just now in the planning stage. The potential of satellite remote sensing data in the post 1991 period is considerable, but to date, research has done a minimum of exploratory work in this area. All agree, however, that future versions of WIMS must be able to access and process high-volume satellite data streams, and communicate the derived fire management products. (It is worth noting that Nebraska is already using a Landsat data-derived "greenness" value in its current fire protection program.)

2.6.2 Forest Sciences Laboratory, East Lansing, Michigan

The most important recent product which may have consequences for the design of WIMS is an Extreme Fire Potential Index. This system was developed for FEMA. It utilizes climatology developed for 140 first-order stations, daily computations using the most current 24 hourly observation from those stations, and MOS forecasts. The results are dispatched electronically to FEMA and NIFCC. The prototype system utilizes data/information provided by a commercial weather forecasting organization. WIMS should be able to access and distribute this new product.

Haines has developed a new meteorological "indicator" of severe wildfire behavior. It utilizes temperature and moisture data to 500 mb. If this index is adopted to supplement the NFDRS, access to the twice/day upper air data will be required.

2.6.3 Southern Forest Fire Laboratory, Macon Georgia

The NFDRS will not change radically until it is replaced in the 90s by the Integrated Fire Technology Package being developed by Rothermel and coworkers at Missoula. It is very probable, however, that provisions will be made before 1991 for subscribers to use hourly NWS and FAA observations to produce fire-danger ratings. Haines´s (East Lansing) severe wildfire behavior "indicator" may also be added. To accommodate such changes, WIMS must be able to access NWS/FAA hourly surface reports and twice/daily upper air data.

Fire danger rating in the mid to late 90s will depend heavily on remotely sensed fuels, fuel moisture, soil moisture, vegetation condition, and precipitation. This implies that later versions of WIMS must be able to access, process and distribute, in near real-time, satellite and NEXRAD data/information. It is almost certain that fire danger information will be managed and presented in a GIS format.

Considerable work is being done to develop a "clean" climatological database for the 13 southern states. The principal source of the data is NCDC. It is planned that the database will include 38 years of surface weather observations from 150 civilian and military stations as well as some 9000 cooperative stations. WIMS should provide the facility to access these and similar data (the East Lansing data set).

2.6.4 Riverside Forest Fire Laboratory, Riverside California

Methods are being developed to use GIS-formatted data/information to plan fuel management activities. Fuels, topography, land use values (homes, etc), and wind climatology are overlaid (fused) and used to screen fuel management strategies. The wind field will be constructed using Fosberg's KRISSEY model, which requires gradient winds, surface temperatures, and topography. The temperature field is constructed using McCutcheon's model, which requires topography and NFWDL temperature climatology.

The long range forecast effort at Riverside has produced predictive equations for some 100 first-order stations. Predictands include: mean monthly daily maximum temperatures; minimum relative humidities; maximum wind speeds; precipitation amount; and precipitation frequency (numbers of events producing 0.1 inch or more). The model is driven by the Climate Analysis Center's 30-day 700 mb height anomaly prediction. The strategy for delivering and utilizing the product has not been resolved to date. It is likely that the processing will be done at NIFCC, and the tabular and color graphic products will be distributed from that facility. WIMS should be able to manage and display GIS-formatted data/information. It must also be able to access CAC and distribute color graphic-formatted products.

2.6.5 Rocky Mountain Forest Range Experiment Station, Ft. Collins, Colorado

The overall goal of the group at RMFRES is to provide state-of-the-art air quality dispersion modeling tools for local, meso- and regional scales, for applications of:

- Ambient air quality (gaseous/particulate)
- acid deposition
- smoke management
- natural and anthropogenic visibility impairment

and other air resource -- related needs for modeling, simulation, data analysis and interpretation. Operational wind field and transport/diffusion models (e.g. TAPAS and PUFF) are online, but the data to drive the models is hard to obtain and difficult to manage. The 1991 time frame WIMS should provide access to NWS/FAA surface and upper air data, RAWS data, Mesonet data, special vertical sounding data (Profiler, acoustic), GOES IR surface temperature maps, and access to digitized topography. Eventually WIMS must have the capacity to acquire, process and communicate very large -size satellite data streams. Powerful and flexible graphics tools will be indispensible.

3. USER-IDENTIFIED NEEDS AND REQUIREMENTS FOR WIMS

This Section organizes, summarizes and explains the high-level, user-identified needs and requirements for WIMS. Each group of ´edited´ needs (Appendices C1 -- C10) has been organized into sets of closely related subneeds. In many instances a narrative is included to provide applications contexts or other relevant clarifying information. A special effort was made to call out those needs or groups of needs that were identified in the same way (or in substantially similar terms) by a number of different Forest Service functions. The discussions of needs are presented in the following sequence:

- General System needs
- Fire and Aviation Management needs
- Air Resource Management needs
- Watershed and Hydrology needs
- Engineering needs
- Range Management needs
- Timber Management needs
- Recreation needs
- Pest Management needs
- Fisheries and Wildlife needs
- Forestry Weather Forecaster needs

The subsections entitled ´General System needs´ and ´Fire and Aviation Management needs´ are presented first because they define the bulk of the requirements for WIMS; the remaining subsections are arranged somewhat arbitrarily, so nothing should be inferred from their order.

As the reader works through this large, varied and somewhat forbidding set of user-stated needs it may be helpful to keep in mind three important findings from the needs assessment:

- The contemporary and near-future needs for weather information management go far beyond the traditional sorts of fire/forestry weather support for Fire and Aviation Management
- Many kinds of weather information needs are common to a number of Forest Service program areas, and in principle can provide significant benefits across a broad spectrum of Forest Service activities. But suitable concepts for use of weather in decision making, and activity-specific measures of incremental decision value or benefit vs. cost, are needed to gauge the value of such weather information
- A properly designed WIMS could accommodate a broad spectrum of users of fire/forestry weather information, both within the Forest Service and in the broader fire/forest community nationwide.

3.1 GENERAL SYSTEMS NEEDS

Throughout the interview process, many users identified weather information management needs that are general functional requirements for the overall WIMS system. This subsection discusses these groups of user-identified WIMS General System Needs.

3.1.1 Communications Interface Requirements

`Active System´ capabilities. Interviewees from Engineering, Recreation, Watershed, and Fire and Aviation Management indicated a widespread need for an "active" system that:

- Responds to event-triggered or exceedance-triggered RAWS transmissions
- Responds to weather warnings and advisories issued by forecasting service (via NOAA Weather Wire, for instance)
- Responds automatically to prompted transmissions by local automatic weather observing equipment, for control and ingest of observational data.

Access to external users. The widespread need exists to acquire and transmit fire and forestry weather data, reports and graphics products, among Federal, State and Canadian agencies. Many of these external agencies now use packet switching networks, for example:

COMPUSERVE -- Department of Interior agencies (BLM, NPS, BIA)
TELEMAIL -- State agencies and Forester´s offices
PRIMENET -- Southern California agencies
DIALCOMP -- Canada

Since (to our present knowledge) there is no plan for interfacing the Forest Service Private Data Network (PDN) communications system to these other networks, external users would need to acquire interfaces to WIMS. However, WIMS could support standard hardware and software interface capabilities to facilitate use by external users on other packet switching networks, and by non-networked users. For example, a non-networked State agency office could connect its workstation to a WIMS workstation using a standard WIMS interface protocol.

Use of WIMS by external agencies would be encouraged by providing telephone access and a limited subset of system functions to those users who may have access only to 'dumb' terminals (e.g., Silent 700s), not a full-featured WIMS workstation or graphics terminal. Many State agencies and some Federal agencies (such as the US Fish and Wildlife Service Refuge offices) manage their data on local stand-alone PC/hard disk systems, but still need ways to communicate with other cooperators.

Access to GOES-East DCP. There is the need to acquire data from RAWS sites in the eastern US. These data are not acquired by the GOES-West DCP, hence are not available from the BLM ground station at Boise. To meet this need, WIMS should be able to access data from GOES-East.

Digital graphics transmission. There is the need to produce fire weather graphics products (for example, the National Fire Severity Potential Maps generated at NIFCC) and transmit those products electronically throughout the Forest Service and to the many Forest Service cooperators. Some individual Forest Service Regional Offices have specific needs to acquire and distribute fire/forestry weather graphics to the forest level.

3.1.2 Augmented RAWS Data Management Functions

Online RAWS station directory. A need has been expressed for an online RAWS station directory that contains station geographic coordinates, elevation, aspect/exposure, instrumentation, and last date of service.

Geographic selection of RAWS stations. Several AFFIRMS users expressed the desire to be able to select, from among all routine RAWS or other weather stations maintained in the fire weather database, those subsets of stations that fall within given radial distances from specified geographic locations, or that lie within specified fire management ´polygon´ zones.

Automated data screening. WIMS should have software modules for data decoding, automatic screening and quality control. We heard repeatedly that the RAWS and manual forestry/fire weather observational data are unreliable. The primary reason cited was instrumentation malfunction due to inadequate maintenance.[1] Other important reasons are inadequate training of observers and transmission/coding/recording errors.

3.1.3 Local Data Management and Storage Needs

Flexible data entry. WIMS should allow the user to group stations; to enter values with absolute or relative trends; to enter observations and forecasts; and the like.

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[1] It is worth noting here that many interviewees stated emphatically an overriding need to ensure that RAWS and manual station instruments must be installed correctly and serviced routinely by properly qualified personnel, so that they can provide accurate and reliable data for WIMS.

Field -- addressable data entry forms. These would allow the user to transcribe data telephoned from manual stations and enter the data into WIMS with minimal coding error. This could help to solve the vexing problem of incomplete and erroneous fire weather data.

Field -- addressable query forms. These will meet the users' need to create their job runstreams more easily and more accurately, and to facilitate the accessing of external systems and databases (e.g., the FIREFAMILY programs at the Fort Collins Computer Center.)

Special meteorological data analysis techniques. In addition to the standard data analysis tools, WIMS will require a number of off-the shelf weather data analysis modules. Some of these routines are needed to transform among standard meteorological units (e.g., to transform between the English and metric systems) and to compute secondary data variables (like $T_{dewpoint}$). Other routines are needed to create standard meteorological data constructs like skew-T diagrams or vertical temperature profiles. Still other specialized routines are needed for spatial interpolation, contouring, wind field representations, and others. Most of these routines are relatively small, standard modules available on user workstations in modern graphical weather information management systems, and all could be adapted for WIMS.

Local data retention. At the same time, many WIMS users express a strong need for online interactive access to relatively small, site-specific, 'active data' files (in particular, the past 30-60 days of observed and forecast weather data and NFDRS indices). The stated storage requirements are typically modest (hundreds of kilobytes appear to be sufficient), and such active data needs to be stored only for a limited time before being discarded or transferred to the permanent archives.

On the other hand, some Forest Service activities (nursery, management, other projects) require permanent retention of unique, static data files, some of which may be very large. Modeling and simulation activities, for example, may require frequent access to large (e.g., of order 100 megabytes) static topographic databases. Such unusually large, specialized data storage requirements could be handled by additional units of dedicated onsite storage at individual sites. This suggestion is noted here, not as a ´need´ per se, but as warranting further evaluation in Tasks 2 and 3.

3.1.4 System-Wide Data Management and Storage Needs

Permanent data retention. WIMS should offer the user a simple, cost-effective way to specify data for permanent retention. WIMS should be able to permanently archive fire/forestry weather data, including RAWS 24-hourly observational data and fire/forestry weather forecasts, to enable users to create:

- Long-term climatological baselines for applications to fire and smoke management, as well as for timber, range, fisheries, wildlife, engineering and recreation management decision support
- Verification of fire weather forecasts and fire behavior/fire danger rating models
- National-scale research and technique development.

The FS/WO (or an interagency group) should specify the formats and files for all parameters to be saved in the national archives. They should specify which of the files can be held temporarily (e.g., for 30-60 days) at individual sites for the convenience of the user. The physical storage and archiving of large, national-scale fire/forestry data files should be fully transparent to the WIMS user. WIMS must provide the physical storage and access facilities for any data not now being archived from AFFIRMS (i.e., at the NFWDL).

Data retention and storage is a decision that, traditionally, has been left largely to the initiative of the individual forest or administrative office. Even today, the archiving of fire weather data via AFFIRMS and the FCCC is not mandatory throughout the Forest Service. Some Forests have for various reasons opted out of AFFIRMS, which has been their only vehicle for fire weather data storage and permanent archival. The loss of potentially valuable fire/forestry weather data and FDRS climatology data will obviously hinder the refinement of fire danger prediction techniques for application on the local level, but the 'lost opportunity' cost of discarding these data has not been quantified. WIMS should offer users a simple, cost-effective way to archive data. Unless the data are retained for future research and applications development, the Forest Service's major investment in RAWS will not be fully realized.

3.1.5 System-wide Standard User Support Utilities

Automatic RAWS data ingest. There is a need for more timely and accurate weather data observations. Automatic data ingest into WIMS would substantially eliminate a major source of data errors, and the data would be available to the user much more quickly. In addition, automatic data ingest would make possible rapid, automatic data decode and quality assurance procedures. Automatic data ingest should include capabilities to control local automatic weather observation stations with WIMS software, e.g., to initiate observing sequences, acquire/decode data, enter data into common and local files, etc. A contract has been let recently (to the current AFFIRMS contractor) to expedite, via electronic file transfers, the process of transferring RAWS data to the ´NFDRS´ portion of AFFIRMS. This modification to AFFIRMS will be operational April 1988.

Standard user support software modules. WIMS needs standard, easy-to-use software modules to automate such functions as uploading and downloading data files, and exchanging data files and graphical products with large external systems (like BLM/ IAMS; FCCC/ NFWDL; NWS/AWIPS; NOAA/ NCDC; SCS/SNOTEL; and others). Wherever possible, WIMS should offer the user a choice of standard, flexible support software modules. This should discourage ´rogue´ software and help to maintain systemwide software configuration controls.

Interactive editing. WIMS should support interactive editing of data, text, and job streams through a vendor-supplied standard text editor. No unusual editing requirements were identified.

Adaptable user interface. The need has been identified for an easy to use, easy to learn, flexible user interface. Users have expressed desire for both command line entry and menu-driven entry interface formats. A few users specifically requested a WIMS interface identical to the DG.

User interface devices, such as a mouse or data tablet, are attractive control methods identified by users. Many users stated the need for online tutorial and 'help' file features, and user-friendly documentation. A lack of user training and post-implementation user assistance has discouraged more aggressive and productive use of AFFIRMS' many features.

Standard data analysis techniques. WIMS should incorporate a standard statistical analysis package that would enable users to compute means, standard deviations, max/min values, cumulative values; to create regressions and trend curves; to generate statistical distributions and goodness of fit tests; to do correlation and covariance analysis; and the like.

Standard system-wide 'business support' packages. Needs were identified for standard business support packages, specifically: spreadsheets; database management; graphics programs; word processing; and communications software.

3.1.6 Graphics Requirements for Forestry Weather Information

One of the most frequent and biggest complaints is that AFFIRMS lacks graphics features. We heard repeatedly that good graphics are vital for efficient analysis and display of fire/forestry weather data and products. Strong preferences were expressed for color graphics, with options for both hardcopy and softcopy. We were told that WIMS should allow a user to create and distribute electronically a variety of forestry weather and other information graphics. Although a large number of specific graphics needs were identified, they can be sorted into a few general categories:

- Conventional ´business graphics´ displays -- e.g., histograms, bar charts, x-y plots, scattergrams, regressions and trend curves, and statistical distributions. One commonly stated need, for example, is to graph and superimpose the current season´s ERC or BI trend curves on various individual past fire seasons, or envelopes of extreme values for these NFDRS indices over various multiyear windows

- Composite maps of weather data fields and related information products -- e.g., areal maps of temperature; moisture; winds; precipitation; snow cover; vegetation and vegetative growth stage; fuel classes; fuel moisture; fire danger ratings; fire management zone ´polygon´ maps of fire potential severity; and the like. A strong preference was indicated for compositing data by use of color. Interest in ´data fusion´ seemed high, particularly among those concerned with fire and smoke management, air quality, and hydrology. Most respondents want area maps referenced to administrative or other geographic boundaries. Mapping scales of interest range from local to national, and temporal scales range from hours to days, months, and seasons.

The interview responses by many potential WIMS users make it clear that graphical representations of geographically-referenced weather data fields are potentially very useful to the Forest Service. A good example is precipitation contour maps (´isohyets´) of severe rain episodes, or of cumulative weekly, monthly (or longer-term) precipitation totals. Such areal maps will be available in the 1990s as data products from the next generation of NWS precipitation radars. Judging from the interviews, areal precipitation maps are of broad potential interest throughout the Forest Service.

For example, Fire & Aviation personnel see their obvious applications to fuel moisture and fire danger rating; Timber and Engineering personnel are interested in precipitation isohyets for assessing soil moisture, road stability, and trafficability; Recreation and Watershed/ Hydrology staff identified applications for real-time runoff prediction and flash flood warning; Engineering staff, for assessing flood damage to high-country trails, bridges, dams, culverts; Range staff, for predicting vegetative conditions in grazing lands; Fisheries & Wildlife and Soils staff, for assessing erosion, siltation, habitat damage. This is a good example of the much broader applications of a class of weather data that is now of primary interest (and most commonly used) by one Forest Service activity group only -- that is, by Fire and Aviation Management.

- Graphics analysis modules specific to representation of weather data -- e.g.; skew-T diagrams; vertical wind field profiles; spatial interpolation and contouring routines; wind barb representations; and some others.
- Simple animation (looping) of observational and forecast maps and imagery Users have stated the need for simple animation capabilities to show the movement of thunderstorms, wind shear lines, sea breezes, surface fronts and derived features (like the ´500 mb anomaly´ map).

3.1.7 Satellite Remotely Sensed Data and Products

By the mid-1990s the Forest Service may have operational requirements for accessing and processing high-volume remotely-sensed data and imagery from existing and planned geostationary and polar orbiting satellite sensor platforms.

Requirements that may arise include the need for: microwave-derived areal measures of soil moisture and fuel moisture; real-time satellite detection of lighting and remote wildfires; visible-image snow cover and microwave measures of snowpack equivalent water content; and multispectral imagery to measure greenness, total biomass and other indices of vegetation condition.

Because the Forest Service community is, for the most part, very new to the concepts and applications of satellite data and imagery, ideas are just now germinating for applications of such new data to operational Forest Service needs. Of course, how the Forest Service perceives the utility and practicality of such remotely-sensed data will depend upon:

- The quality, resolution, timeliness and relative costs of satellite weather imagery and products to be offered both by the Government (via NOAAPORT) and/or by private industry by the mid-90´s
- The success of Forest Service Research in developing new operational algorithms to exploit these new data sources, and to quantify the benefit to cost ratios of introducing this technology for routine field use
- The willingness of the Forest Service operational community to design and carry out experiments to evaluate the practical value of these new data/imagery products.

If the Forest Service intends that WIMS will have the flexibility to take full advantage of these rich new information sources in the 1990´s, the WIMS system architecture must accommodate the eventual use of extensive color digital graphics. A color graphics workstation with local digital image computation support (akin to those now planned for, say, the NWS AWIPS system) will become indispensible to the WIMS user environment.

As was apparent from the interviews, though, much needs to be done to bring the Forest Service into readiness to exploit these new remotely-sensed data sources. For this reason the mid-90s WIMS requirements for data, graphics and imagery processing cannot be fully described now.

3.2 FIRE & AVIATION MANAGEMENT NEEDS

Of all the Forest Service functional staff specialists contacted in this study, those best able to articulate their needs for weather and related information were the F&AM staff specialists. This was to be expected because, since the early 1900s, fire specialists have amassed a great deal of experience in the collection and use of weather data and information. Fire management, an increasingly complex program, encompasses the traditional components of wild fire control -- prepositioning, prevention, detection, and suppression -- and the more recent challenges of fire use (prescribed fire) and smoke management.

Fire managers at all organizational levels in the Forest Service (national, regional, and forest) routinely make difficult, weather-sensitive decisions about national-scale movement of equipment and crews, prescribed fire, contain-confine-control strategies for suppression, and smoke management. Time scales for fire management decisions range from less than an hour to as much as 30 days; and spatial scales from less than 10 acres to continental.

Fire management planning is a rigorous process that incorporates complex simulations of wild fire occurrence, behavior, and detection and suppression actions. Historic weather is a major driver of the fire occurrence and fire behavior simulation models, and its importance for fire management planning cannot be overstated.

The Forest Service's fire management program imposes unique requirements for close cooperation among the various governmental agencies and private protective associations, because wild fire respects no boundaries. This means that weather and fire data/information must flow smoothly among the many cooperators, across Federal and state agency boundaries, and into the private sector.

3.2.1 Weather Observations

Interviewees stated needs for a variety of traditional and non-traditional observational weather data:

Daily surface weather data are needed for evaluating the fire danger on national, regional, and forest scales. Daily surface weather observations have traditionally been provided from manual weather observing networks operated by Federal and state land management agencies. These data will continue to be the mainstay of the fire-danger rating program, but will certainly be augmented in the future, particularly in the East, by data from the NWS and FAA first order weather stations. Many of the manual stations are being automated with RAWS, hence communication and management of RAWS data is a special WIMS need.

Drought and soil moisture information developed by the Climate Analysis Center (CAC) in Washington D.C. is needed to assess regional scale moisture anomalies. This information is used at the Forest Service's national and regional levels to complement fire-danger information.

RAWS and P-RAWS (Portable RAWS) are usually deployed on a short-term basis to provide higher resolution surface weather information (better spatial and temporal resolution) for project-level activities such as prescribed burning. These data are typically communicated to the primary user via GOES and the BLM ground station at NIFCC, but other methods such as telephone, UHF radio, and microwave are used. Data of this class are not typically shared beyond the boundaries of the administrative unit, except with the NWS. WIMS must provide the capability to ingest these data for local use and for transmission to specific cooperators.

Hourly first order NWS and FAA surface weather data; visual and infrared satellite cloud imagery, surface temperature and moisture fields. These data types are the basic information sources used by fire weather specialists to monitor the movement of weather systems which may affect the behavior of wild fires and prescribed fires. The real need is for continuous weather watch by a trained meteorologist when a critical fire event is underway. However, if continuous, reliable fire weather forecast service is not available, the basic raw information could have great value to the decision maker.

Lightning data is available to cooperating agencies from the BLM's Automated Lightning Detection System (ALDS), the SUNY National Lighting Detection Network at Albany, NY, and commercial sources. ALDS data are communicated in "near" real time via the BLM's Initial Attack Management System (IAMS). As the National Forests' network of lookouts is cut back, ALDS data will become more and more important to the National Forest System for managing detection activities and prepositioning initial attack elements.

Weather radar summaries are needed by ALDS users to indicate which lightning-impacted areas received rain and which did not. There is a further need to graphically overlay or fuse the radar and lightning data fields. NEXRAD, the NWS´ next generation weather radar for the 1990´s, will provide digitized rainfall accumulation and rainfall rates, data that will be useful for developing the fuel moisture fields needed for evaluating burning conditions between surface weather observing sites.

Upper air data are needed for predicting smoke drift and dispersion. In the near future those data will drive models that construct boundary layer wind fields and temperature profiles which, in turn, will drive smoke dispersion and fire behavior models.[2]

3.2.2 Weather Forecasts

Weather observations provide essential information about the current state of fuel moistures and the atmosphere, but to make informed choices the decision maker must also have forecasts of future conditions. Fire specialists have identified requirements for three categories of forecasts:

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[2] At present, for example, the Okanagan National Forest uses the predicted 850 millibar wind, along with topographic data, to construct a boundary layer wind field. In turn, the wind field is used with fuel and topographic data to predict fire spread rate, which is an input for developing the initial dispatch to a wild fire.

- extended range (10 to 30 days and seasonal)
- medium range (three to 10 days)
- short range (zero to three days)

Thirty-day weather forecasts issued twice monthly by NMC are used by the NIFCC Intelligence staff (Washington Office), together with climatology-based guidance from CAC, to make regional-scale 30-day projections of wild fire severity. These projections are used to justify requests to the Congress for emergency/severity funding. Extended range forecasts are monitored at the regional level, but few actions are taken based on the forecasts unless a dangerous situation exists. Regions 1 and 2 are making monthly subregional-scale fire severity projections similar to those made for the entire country at NIFCC.

WIMS should also have the capability to access, acquire and distribute extended-range forecasts from the European Medium Range Forecast Center, where notable forecast skill in the 15-day time frame has been developed.

Three to five-day and six to 10-day forecasts issued by NMC are used extensively at the national and regional levels to guide decisions to alert, mobilize and deploy suppression personnel and equipment. Regional staffs base requests to the Washington Office for severity funding partly on medium-range forecasts. Medium-range forecasts are considered at the forest level when selecting a contain-confine-control suppression strategy for a newly reported fire. Medium-range forecasts are particularly important to wilderness natural prescribed fire programs. Managing a prescribed burning program requires medium range forecasts, particularly precipitation forecasts. The most important need, in this instance, is to predict the moisture contents of the slow drying, longer (100-hour and 1000-hour timelag) fuels to project the time period when those fuels will be in prescription.

Twenty four to 72-hour forecasts are needed more at the regional, forest, and district levels than at the Washington office level. This time frame is appropriate for addressing the likelihood of synoptic and mesoscale meteorological events that can trigger a fire emergency. In the West it is a thunderstorm or foehn wind (East, Mono, and Santa Ana winds on the west slopes of the Cascade and Sierra Mountain Ranges); in the East it is commonly the winds in the warm sector of a large, intense low pressure storm. This time frame also corresponds to initiating prescribed burn project operations, making air quality predictions (regional smoke advection and dispersion), as well as predicting moisture contents of the smaller, more rapid drying (10-hour timelag) dead fuels.

Twelve to 24-hour forecasts are key to the successful execution of both wild fire suppression and prescribed burning plans. Twelve to 24 hours out, the forecaster can be expected to address critical site-, and time-specific conditions and meso-scale meteorological events such as sea breeze and topographically induced winds which are so critical to fire behavior and smoke dispersion.

Nowcasting (less than three hours) is used for predicting fire behavior on wild fires and is extremely important when conducting a prescribed burn. It is at this point that fire specialists need the latest observational data to enable them to monitor the synoptic-, meso-, and topographic scale weather systems that have the potential to affect fire behavior.

Twelve to 72-hour gridded upper air forecasts have great value for predicting smoke dispersion. Upper air forecasts may have the potential to highlight conditions that cause dangerous fire behavior. For instance, work done in Canada has associated wildfire emergencies with the rapid onset of negative 500 millibar height anomalies. In the interviews, fire specialists have voiced considerable interest in identifying, tracking, and projecting negative 500 millibar height anomalies.

3.2.3 Satellite Remotely Sensed Data

Researchers and fire specialists foresee a need for WIMS to have the facility to acquire and distribute NOAA/NESDIS satellite remotely sensed data in near real time. A study to assess the potential of multispectral near-IR data to evaluate vegetation "greenness" has been recently proposed. Other such studies are likely, e.g., studies to evaluate soil moisture and snow cover/water equivalent information derivable from satellite-based sensors in the 1990s. Future satellite data techniques may offer low-level wind field and temperature soundings. Researchers speculate that the future direction for developing fire technology may require combining such remotely sensed data fields with topography and fuels data fields in a Geographic Information System (GIS).

3.2.4 National Scale Data Archive Needs

Daily and hourly (RAWS) weather data collected at Class 1 stations should be saved in an archive. The

National Fire Weather Data Library at FCCC has established the value of a weather archive for planning and post analysis of significant fire events. The NFWDL does not contain hourly RAWS data, nor does it store ALDS data. Researchers and fire specialists have identified the need to develop an expanded forestry weather archive in which to store daily and hourly weather observations from Class 1 forestry-net stations, forestry weather forecasts, and lightning observations. WIMS must provide the means by which daily and hourly weather observations from Class 1 forestry-net stations, forestry weather forecasts, and lightning observations are formatted and transmitted to a national-scale data repository.

3.2.5 Online Current Data Needs

The sharing of weather and fire data and information among federal and state agencies and private cooperators makes fire management unique among other Forest Service functions. AFFIRMS provides that capability by incorporating common, national-scope files of observed and predicted fire weather and fire danger ratings, as well as narrative forecasts. Fire specialists have said that WIMS must provide common, online files of the most current:

- Observed and predicted weather for Class 1 forestry-net stations
- Current and predicted fire danger ratings
- Forestry weather narrative forecasts.

Users were very outspoken in stating the WIMS need for online, editable files of the most current 30 to 60 days of the same data/information. (AFFIRMS does not provide this capability.) Ready access to these data would, for instance, enable the fires specialist to plot the various fire danger parameters over time in order to illustrate trends and to display departures from long-term averages. These data would also be used to verify forecasts and to generate fire/forestry weather statistics. Maintaining these data in temporary files before transmitting them to the archives will allow detected observation errors to be corrected and fire danger ratings to be recomputed and updated.

3.2.6 Access to External Weather Information Sources

Users told us that WIMS must provide easy to use facilities for accessing and downloading fire/forestry weather and other data and information products such as the following:

- Forestry weather observation and forecast data from the National Fire Weather Data Library (NFWDL) at FCCC, for processing with the NFDRS analysis program, FIREFAMILY; the prescription-development programs, RXWEATHER and RXBURN; and the fire management planning programs, NFMAS (Forest Service) or CFES (California Fire Economic Simulator)
- Fire reports from the National Fire Occurrence Data Library (NFODL) at the FCCC, used with NFMAS and standard statistical and database management software to develop wild fire statistics
- Palmer Drought Index and Crop Moisture Index information from the NOAA Climate Analysis Center (CAC), used in the development of the extended range fire severity projections;
- Hourly and daily surface observations and upper air observations from the NOAA National Climatic Data Center (NCDC) and/or

from the local office of the state climatologist. These data would be used to develop specialized climatologies and decision aids for areas not covered by forestry-net weather stations, or for which the forestry-net coverage is inadequate (low station density, short period of record, or poor seasonal coverage)

- RAWS and ALDS data from the BLM´s Initial Attack Management System (IAMS), needed to supplement Forest Service forestry-net weather observations;
- Snow data from the Soil Conservation Service´s SNOTEL data bank from which to judge rate of snow cover retreat.

3.2.7 Access to Standard Fire Management Software

The various computer programs used by fire specialists are scattered among several computer systems. They require unique, often clumsy, procedures for system access, input data file construction, program execution, and output retrieval. This "non-uniformity" of program-user interfaces imposes an unnecessary burden on fire specialists who use some of the programs only rarely. For this reason, some programs are not being used at all, or (worse) are being used inappropriately, and program execution work is being shifted to computer specialists who typically have a limited understanding of the fire management domain.

Throughout the interview process, therefore, fire specialists have repeatedly emphasized that WIMS should give them easy access to standard fire management software. (e.g., with macro-command-based routines, clean and uniform program-user interfaces, help files, and the like) so that they will be able to set up and execute these programs for themselves:

- National Fire Danger Rating System (NFDRS) is available on AFFIRMS and on hand-held programmable calculators (TI-59 and HP-71B). WIMS must retain the NFDRS functionality of AFFIRMS
- FIREFAMILY is a set of batch programs used to construct and analyze fire-danger rating history. FIREFAMILY component programs include FIRDAT, FIRINF, and SEASON. FIREFAMILY is resident on the FCCC, and operates on data sets drawn from the NFWDL
- RXBURN, RXWEATHER, and WINDOW (under development) are FCCC-resident programs used to develop and evaluate the climatological "saneness" of burning prescriptions. They operate on data sets drawn from the NFWDL
- NATIONAL FIRE MANAGEMENT ANALYSIS AND PLANNING SYSTEM (NFMAS) is the package of programs used by the Forest Service to develop and test its fire management organizations and strategies. NFMAS, a set of batch programs at FCCC, requires data sets from the NFWDL and the NFODL
- BEHAVE is the latest version of the Fire Behavior Prediction System. (The relationship between BEHAVE and the FBPS is analogous to the relationship between AFFIRMS and the NFDRS). BEHAVE is available as an interactive program at FCCC, on the Data General, and a PC MS-DOS version has been recently released. BEHAVE is currently undergoing its "final" update at the Intermountain Fire Sciences Laboratory.
- FIRECAST is similar to BEHAVE, but (unlike BEHAVE) FIRECAST gives the user a choice of using the FBPS or NFDRS processors and fuel models. It is available only on the Forest Service´s PRIME computer located at the Region 5 South Zone Fire Coordination Center in Riverside, California. FIRECAST is an interactive program

- Smoke dispersion models are used by Air Quality research and operations specialists, but are not now generally available to other Forest Service staff. First-generation complex terrain dispersion models suitable for more general use are expected to be available in the early 1990´s.

3.2.8 ´Active´ System Capabilities

Numerous fire management specialists have stated a need for the WIMS to receive "urgent" information and get the attention of an operator. Information would include messages, weather warnings and advisories, and event/exceedance-triggered RAWS transmissions (soon to be available via the NOAA/NESDIS GOES emergency channel).

WIMS should also be able to control a local automatic weather observing system and manage the observing system´s data.

3.2.9 Communications with Cooperators

Fire management specialists at all levels of the Forest Service (national, regional, and national forest) have voiced their dissatisfaction with the complicated procedures for accessing, and being accessed by, the external communications networks of cooperators. WIMS should offer the user easy routines for access to cooperators´ electronic mail/message systems. Though the issue is also addressed in Section 3.1, General System Needs, it is important to document here a more comprehensive (but not necessarily complete) list of cooperators to which Forest Service Fire Management and Aviation staff require electronic mail/message access:

- U.S. Federal agencies: Bureau of Land Management; National Park Service; Bureau of Indian Affairs; National Fish and Wildlife Service; Federal Emergency Management Agency; National Weather Service; National Environmental Satellite Data Information Service; Department of Defense
- State Agencies: California, Oregon, Minnesota, Florida, others
- Canadian agencies: National Canadian Forest Service; individual Canadian Provincial Forest Services

TABLE 3-1
FIRE & AVIATION MANAGEMENT

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Weather observations

Forestry/Fire Net

- Hourly (RAWS/P-RAWS)
- Daily (manual, RAWS)

BLM IAMS

- RAWS
- ALDS

NOAA/NESDIS/NWS and FAA

- Hourly surface (airways)
- Hourly radar summary
- NEXRAD precipitation rate/cumulative amount
- Cooperative observer network
- Twice-daily upper-air temperatures and winds to 500 mb
- Visual and IR satellite cloud imagery

NOAA/Climate Analysis Center

- Palmer Drought Index and Components
- Crop Moisture Index and Components

Weather forecasts

NOAA/NWS/RFC

- Severe weather/flood warnings and advisories

Fire weather (surface)

- 0 - 3 hours (site and time specific)
- 12 - 24 hours (site and time specific)
- 24 - 72 hours
- 3 to 5 days
- 6 to 10 days
- 10 to 30 days

TABLE 3-1
FIRE & AVIATION MANAGEMENT (Continued)

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Weather Forecasts (Continued)

Smoke dispersion

- 1 - 24 hours
- 24 - 72 hours
- Sea breeze
- Drainage winds
- Upper air temperatures and winds to 500 mb (12 to 72 hours)
- Stability and lifted index (12 to 24 hours)
- Low level winds (12 to 24 hours)

NOAA/Climate Analysis Center

- Palmer Drought Index and Components
- Crop Moisture Index and Components

European Medium Range Forecast Center

- Extended range forecast products

Fire Severity forecasts

- 30 day national outlooks (from NIFCC)
- 15 to 30 day regional outlooks

Realtime access to remotely sensed data

- Vegetation "greenness" (multispectral)
- Soil moisture (microwave)
- Snow cover/water equivalent (multispectral and microwave)

National/regional scale data archives

- Once/day forestry/fire net manual observations
- Hourly forestry/fire net automatic (RAWS) observations
- ALDS observations
- Forecasts for forestry/fire net weather stations

TABLE 3-1
FIRE & AVIATION MANAGEMENT (Continued)

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Online national-scope shared files

- Forestry/fire net weather data/information, observed and predicted
- Fire danger rating data/information, current and predicted
- Forestry weather narrative forecasts

Online current local data files -- 30 to 60 days

- Forestry weather data/information, observed and predicted (including data from non forestry-net sources
- Fire danger rating data/information, current and predicted

Access to external weather information sources

- National Fire Weather Data Library (NFWDL)
- National Fire Occurrence Data Library (NFODL)
- NOAA Climate Analysis Center, (CAC)
- NOAA National Climatic Data Center, (NCDC)
- BLM Initial Attack Management System,(IAMS)
- Soil Conservation Service SNOTEL
- Regional/state climatology offices

Access to standard fire management software

- National Fire Danger Rating System (NFDRS)
- FIREFAMILY
- Fire Behavior Prediction System (BEHAVE)
- FIRECAST
- National Fire Management Analysis and Planning System (NFMAS)
- RXBURN
- RXWEATHER
- WINDOW (being developed)
- Smoke dispersion models

TABLE 3-1
FIRE & AVIATION MANAGEMENT (Continued)

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Active system capabilities

Responds to

- Event/exceedance-triggered RAWS transmissions
- Weather warnings and advisories by forecasting service
- Messages

Interfaces to

- Local automatic weather observing equipment for control and ingest of observational data

Communications with cooperators

- Federal agencies
- State Agencies
- Canadian Agencies

3.3 AIR RESOURCE MANAGEMENT NEEDS

The air resource-related weather information management needs of the Forest Service address both operational and research requirements. The Forest Service's operational requirements derive from (a) its responsibility for protecting Air Quality Related Values, including visibility, in Class 1 Wilderness areas under the Prevention of Significant Deterioration and visibility protection provisions of the 1977 Amendments to the Federal Clean Air Act; and (b) the need to comply with state programs to manage smoke from prescribed burning. In these roles, the Forest Service participates with states in the review of new source permits and ongoing compliance monitoring programs. The FS's air quality-related operational responsibilities will surely grow in response to several issues:

- Fine Particulates. The new EPA National Ambient Air Quality Standards for fine particulates, especially the new maximum hourly 'PM10' standard
- Acid Deposition. Atmospheric acid deposition onto National Forest watersheds, and associated impacts on vegetation and wildlife. The acid deposition research program dovetails with Watershed/Hydrology, Fisheries/Wildlife, and Recreation, among others
- Visibility Impairment. Visibility obscuration due to wildfire and prescribed fire smoke (and 'induced fog') is a safety concern, especially in the Southeast. Degradation of scenic visual quality induced by mesoscale/regional concentrations of natural and anthropogenic aerosols is a statutory concern that most affects recreation activities, primarily in the West. The states have written, or are in the process of writing, supplements to their State Implementation Plans to improve and protect

visibility, including steps to reduce 'regional' haze.

The Air Resource -- related weather information needs are already included, for the most part, in Section 3.1, General System Needs, and Section 3.2, Fire and Aviation Management Needs. However, the Air Resource Management activity has additional and important special weather information-related requirements:

Linking meteorological data to diagnostic, simulation and graphical display models. WIMS should allow the user to access precomputed and prestored wind and temperature fields (developed from RAWS, NWS upper air data, GOES IR surface temperatures or other sources of equivalent weather data) and to link these fields to large topographic data files (of order 20 megabytes) and existing diagnostic wind field models (e.g., TAPAS). Graphical display of model output fields in three-dimensional terrain is an essential need for interpretation and analysis of the modeling results.

Access to existing air quality transport/diffusion models. Certain users have the requirement to access large mesoscale/regional air quality models and to link them to wind field model outputs, for execution of regional-scale and mesoscale air quality simulations. WIMS should give these users access to existing models hosted on a local DG processor. Graphical display of model output fields in three-dimensional terrain is an essential need for interpretation and analysis of the modeling results.

Access to surface and upper air climatology. This data is needed for both smoke dispersion forecasting and for evaluating PSD permit appications. WIMS should give users the ability to access files created from datatapes of upper air and surface climatology archived at the NOAA National Climatic Data Center (NCDC) in Asheville, NC.

Use of archived and real time RAWS and other weather data for site-specific air quality modeling. For permitting review and other applications of standard EPA Gaussian air quality models, related WIMS needs include: ability to reformat FS RAWS data into surrogate NCDC ´TDF14´ datatape format and to compute equivalent ´Turner stability classes´ (by merging RAWS wind and temperature (or radiometer) data with cloud cover observations from a nearby weather observing station); and ability to interactively access and execute EPA UNAMAP air quality models with reformatted RAWS data and conventional NCDC ´TDF´14 data.

Processing special sounding data. Analysis modules are needed to process special soundings (e.g pibal ascents, acoustic sounder runs) from manual or digital tape inputs; extract winds and temperatures; compute and interpolate mixing heights; and plot soundings.

In addition to these current needs, future potential needs were also identified for satellite-derived surface and near-surface temperature and wind field data in the 1990´s time frame.

TABLE 3-2
AIR RESOURCE MANAGEMENT

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Weather observations

Forestry/Fire Net

- Hourly (RAWS/P-RAWS)

BLM IAMS

- RAWS

NOAA/NESDIS/NWS

- Hourly surface (airways)
- Upper air temperatures and winds: 850, 700, and 500 mb
- Stability
- Special sounding data
- Visible and IR satellite cloud imagery and surface temperatures

Weather forecasts

Surface weather

- 0 to 24 hours (site- and time-specific)
- 24 to 72 hours (local, regional)
- 3 to 5 days

Upper air weather

- Low level winds
- 850,700 and 500 mb winds, 12 to 72 hours

Smoke dispersion

- 0 to 24 hours (site- and time-specific
- 24 to 72 hours (local, regional)
- Stability and lifted index
- Sea breeze
- Drainage winds

TABLE 3-2
AIR RESOURCE MANAGEMENT (Cont.)

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Climatology

NOAA/National Climatic Data Center (NCDC)

- NCDC TDF 14 data files (surface, upper air)

Remotely sensed data

- Profiler Data

National/regional scale data archives

- Once/day forestry/fire net manual observations
- Hourly forestry/fire net automatic (RAWS) observations

Online national-scope shared files

- Forestry weather narrative forecasts, including smoke dispersion guidance

Access to external weather information sources (climatology)

- National Forestry Weather Data Library (NFWDL)
- National Climatic Data Center (NCDC)
- BLM Initial Attack Management System (IAMS)
- Regional/state Climatology offices
- EPA, state and local air quality agencies

Access to standard fire management software

- National Fire Danger Rating System (NFDRS)
- FIREFAMILY
- RXBURN
- RXWEATHER
- WINDOW (in development)

TABLE 3-2
AIR RESOURCE MANAGEMENT (Cont.)

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Access to air quality transport/diffusion models

- TAPAS
- KRISSY
- EPA UNAMAP models
- Other EPA and state-recommended air quality models (applicaiton- and site-specific)

Access to visibility impairment models

- EPA-recommended visibility models (application- and site-specific)
- State-recommended visibility models (application- and site-specific)

Active system capabilities

Responds to

- Air stagnation and smoke mangement advisories
- Messages

Communications with cooperators

- Federal agencies
- State agencies

3.4 WATERSHED AND HYDROLOGY NEEDS

The watershed and hydrology-related weather information management needs of the Forest Service address both operational and research missions. These include:

- Realtime streamflow and flood warnings
- Prediction of watershed storage level and flood potential
- Prediction of long term erosion and sedimentation
- Development of better hydrological and erosion models for FS watersheds

Although many of the Watershed and Hydrology-related WIMS needs are already included, for the most part, in Section 3.1, General System Needs, and Section 3.2, Aviation and Fire Management Needs, regional and forest level specialists have a number of important special requirements for weather data. These data fall largely into three time classes: climatological/historical data; current/recent season data; and real time/near-real time data.

3.4.1 Climatological Data

To apply their watershed and hydrographic models and other assessment tools, FS hydrology specialists require access to the following climatological data sets:

- Long-term records and maps of monthly, seasonal, annual precipitation (rain and snow) and snow core data. Extreme values of precipitation amounts and rates are of particular interest. This data will typically be available from the NOAA National Climatic Data Center (for NWS observing stations only), state climatology offices, and Forest Service locations. The older data records are mostly available in hard copy format only. There is an implied need for WIMS to offer readily-customized data templates for transcription and encoding of hard copy climatological data records. Some users expressed a clear preference for contour maps of areal precipitation ('isohyetals') on forest and regional scales.

- Long-term records of monthly, seasonal, annual stream gauge readings and stream flow summaries. The data sources are: the U.S. Geological Survey (USGS), the Soil Conservation Service (SCS), and in some cases, the offices of state climatologists. Extreme values are of particular interest. As above, WIMS should enable the user to retrieve and store selected portions of these data records. A number of users expressed needs for better access to SCS and USGS streamflow databases.

3.4.2 Current and Recent Season Data

The sources of current and recent season hydrology data are the USGS, the SCS and in some cases the offices of state climatologists. Extreme values are of particular interest. Forest Service hydrologists provide critical information to other Forest Service functions. For example, estimates of seasonal snowfall accumulation, spring runoff, and flood potential are cited as important to Engineering (flood damage control), Recreation (recreational safety, floating/rafting conditions), and Fisheries and Wildlife (sedimentation), Timber and Range (vegetation development and vehicular access).

Estimated dates by which given elevations/sites will be substantially free of snow cover are important for Timber (spring planting; winter/spring logging) and Fire and

Aviation Management (prescribed burning). The day-to-day variations of soil moisture, air and soil temperatures are important to Engineering, Recreation, and Timber for road and off-road trafficability; and to Range for projecting vegetation greenup and growth.

The Soil Conservation Service's SNOTEL network telemeters daily readings from high-elevation automatic snow monitoring stations. The data fields include: snow depth and equivalent water, air temperature, wind speed and direction, recent precipitation accumulations, and soil temperature. Access to SNOTEL automatic stations is possible through the DG system. The need was also stated for monthly data from manually operated SNOTEL stations. Overall, though, the SNOTEL network is sparse and data from the high-elevation monitoring sites are not reliably extrapolatable to lower elevations of interest to the Forest Service.

Stream gauge data were identified as available from the USGS and from NWS River Forecast Centers. We were not told of any FS-operated stream gauging stations.

Data on current and cumulative recent rainfall is important on time scales that range from increments of 5-10 minutes, to periods of hours to days. Short duration/high density rainfall data are needed to drive runoff models, particularly in the West. A heavy rain-on-snow event may pose a severe threat for sudden flooding. Timely predictions of such events, and good estimates of total areal precipitation accumulations, are important needs. WIMS should provide modules to interpolate daily (weekly/monthly) areal precipitation, snow cover and equivalent water from snow and rain gauge station observations. A related future (1990's) WIMS need will be to acquire, for those national forests within the available coverage area of the NEXRAD system, forest-scale areal precipitation intensity and cumulative totals.

The need was expressed for display of rainfall data as isohyetals overlaid on two-dimensional topographic maps.

Rain gauge data is collected at certain Forest Service watershed experiment/administrative sites for special investigations (e.g. for canopy interception studies), but these data are highly site-specific and site-intensive. Apparently there is no general requirement for WIMS to automate the collection and storage of this data, or to make such data generally available to other potential users.

3.4.3 Real Time Weather Data and Forecasts

There is an operational need for reliable realtime data and timely forecasts of extreme rain (particularly rain-on-snow), storm track movements, and unusually warm conditions favoring rapid snowmelt, to provide as much advance warning as possible of accelerated runoff and flooding. For research, needs exists for quantification of short-term variations in areal precipitation intensity over forest scales. This need can only be met by NEXRAD or satellite-derived precipitation estimates.

TABLE 3-3
WATERSHED AND HYDROLOGY MANAGEMENT

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Weather observations

Forestry/Fire Net

- Hourly (RAWS/P-RAWS)

NOAA/NESDIS/NWS

- Precipitation rate/cumulative amount
- Short duration/high intensity rainfall data
- Cooperative observer network

NOAA/Climate Analysis Center

- Palmer Drought Index and components
- Crop Moisture Index and components

State and local weather station nets

- Raingage data

Weather forecasts

NWS/RFC

- Severe weather/flood warnings and advisories
- Freeze/thaw elevations
- Quantitative Precipitation Forecasts
- Extended range forecasts (3 to 5, 6 to 10, 30+ days)

European Medium Range Forecast Center

- Extended range forecast products

TABLE 3-3
WATERSHED AND HYDROLOGY MANAGEMENT (Cont.)

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Remotely sensed data

- Snow cover/water equivalent multispectral and microwave)

National/regional scale data archives

- Snow course and stream flow data files

Online national-scope shared files

- Forestry weather narrative forecasts
- State, USGS and SCS snow/stream data files

Online current local data files

- Forestry weather narrative information
- State, USGS and SCS snow/stream data files

Access to external weather information sources (climatology)

- National Forestry Weather Data Library (NFWDL)
- National Climatic Data Center (NCDC)
- NOAA Climate Analysis Center (CAC)
- BLM Initial Attack Management System (IAMS)
- Soil Conservation Service SNOTEL system
- USGS
- Regional/state Climatology offices

TABLE 3-3
WATERSHED AND HYDROLOGY MANAGEMENT (Cont.)

SUMMARY OF WEATHER DATA/INFORMATION NEEDS
Access to standard sedimentation and erosion models • US Army Corps of Engineers Hydrological Engineering Center Model • WEPP erosion prediction program
Active system capabilities • Event/exceedance-triggered RAWS transmissions • Weather warnings and advisories • Messages
Responds to • Event/exceedance-triggered RAWS transmissions • Weather warnings and advisories • Messages
Communications with cooperators • Federal agencies • State agencies

3.5 ENGINEERING NEEDS

The Engineering-related needs for operational weather information identified by users include:

- Real-time and short term forecasts for planning and scheduling of road construction and maintenance work
- Short term weather warnings for worker health, safety, and equipment protection
- Current precipitation and streamflow data for bridge and culvert structural protection
- Climatological maximum precipitation rates for bridge and culvert design

Many of the WIMS needs implied by these activities are already included in earlier sections. Engineering specialists also have specific needs for weather data/information management. These needs fall into the following time classes: (a) real time weather and short-range weather forecasts; (b) cumulative totals of recent data; and (c) climatological probability data .

3.5.1 Real Time Weather Data and Forecasts

Several Engineering respondents in different Forest Service Regions expressed the need for site-specific weather briefings to protect health and safety of the Engineering workforce. The variables needed are severe temperature, extreme winds, heavy precipitation, and a ´human comfort index´ related to severe weather conditions. Other real time and short-term weather forecast needs identified by Engineering include:

- Access to NWS River Forecast Center river and streamflow information (both to protect worker safety and to assist in flood damage assessment)
- Access to snowpack data from representative stations in the SCS SNOTEL system (for structural safety)
- Local 12-hour predictions of severe rainfall and rain-on-snow conditions at higher elevations, (for flooding, relative to bridges and culverts designed for 1:50 year and 1:100 year design criteria)
- Current and short-term predictions of temperature lapse rate in elevated terrain to determine freeze line and its expected change), for decisions on vehicle trafficability (e.g., whether snow will remain frozen or runoff will occur)
- One to two day forecasts of temperature and precipitation (for concrete placement and hardening)
- Real time cloud cover (for go/no go decisions on areal reconnaissance)
- Two to seven day project-scale forecasts (for work planning and road construction decisions).

3.5.2 Cumulative Recent Data

Various Engineering respondents said they need total recent rainfall and snowpack accumulation data to make operational decisions for protecting bridges and culverts. Engineering has some unique requirements for cumulative weather. These include: the total number of summer degree days over 40F (to monitor curing of new road surfaces) and the total number and duration of freeze/thaw cycles per month (to predict the lifetime of soil stabilizers). WIMS should have the capability to track these cumulative totals automatically and to alert the user when preset criteria are exceeded.

These site-specific needs require appropriate localized data collection; it appears that these special needs could be met readily with portable RAWS units. So far as we could tell, though, Engineering personnel know little about RAWS, and they are not aware of the capability and flexibility that portable RAWS units offer for site-specific weather monitoring.

3.5.3 Climatological Probability Needs

Forest Service Engineering specialists require access to the following climatological data, probabilities and recurrence-interval information sets:

- Climatological values of weekly/monthly temperature and precipitation, for locations with representative elevation and exposure. Extreme values are of particular interest. This data may be available from historical data at Forest Service locations, as climatological monthly summaries from the NOAA National Climatic Data Center (for NWS observing stations and cooperative observers), and from offices of state climatologists
- Probability distributions from climatological data files. For example, needs exists for probability distributions of: multiday rainfall and total rainfall accumulations (to assess haulroad trafficability during hauling season); and of number of days per month with precipitation > 0.1′, for designing logging roads and planning road maintenance
- Climatological extreme-value probabilities of peak hourly and streamgage values and peak 24-hour cumulative rainfall. These

are needed for input into unit hydrograph models for runoff prediction. The data sources are the U.S. Geological Survey (USGS)

- Climatological cloud cover statistics, needed for scheduling aerial survey photography

TABLE 3-4
ENGINEERING

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Weather observations

Forestry/Fire Net

- Hourly (RAWS/P-RAWS)
- Daily (MANUAL, RAWS)

BLM IAMS

- RAWS
- ALDS

NOAA/NESDIS/NWS

- RFC river and streamflow information
- Precipitation rate/cumulative amount
- Severe rainfall/rain-on show observations
- Cooperative observer network
- Cumulative recent data (degree days, freeze/thaw cycles)
- Visual and IR satellite imagery and surface temperatures

NOAA/Climate Analysis Center

- Palmer Drought Index and components
- Crop Moisture Index and components

Weather forecasts

Surface weather

- Severe weather/flood warnings and advisories
- Local 12-hour predictions of severe rainfall/rain-on-snow
- Temperature lapse rates in elevated terrain
- 0 to 24 hours (site- and time-specific)
- 24 to 72 hours (site- and time-specific)
- Extended range forecasts (3 to 7 days)

TABLE 3-4
ENGINEERING (Cont.)

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Weather Forecasts (continued)

Site specific weather briefings

- Severe temperatures
- Extreme winds
- Heavy precipitation
- Comfort Index

National/regional scale data archives

- Once/day forestry/fire net manual observations
- Hourly forestry/fire net automatic (RAWS) observations
- Snow course and stream flow data/information

Online current local and national -scope shared files

- Forestry weather data/information
- State, USGS and SCS snow course/stream files

Access to external weather information sources (climatology)

- National Forestry Weather Data Library (NFWDL)
- National Climatic Data Center (NCDC)
- NOAA Climate Analysis Center (CAC)
- BLM Initial Attack Management System (IAMS)
- SCS SNOTEL system
- USGS
- Regional/state Climatology offices

TABLE 3-4
ENGINEERING (Cont.)

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Active system capabilities

- Event/exceedance-triggered RAWS transmissions
- Weather warnings and advisories
- Exceedances of cumulative totals, with automatic alerts

Interfaces to

- Local automatic weather observing equipment for control and ingest of observational data

Communications with cooperators

- Federal agencies
- State agencies

3.6 RANGE MANAGEMENT NEEDS

Range management needs for weather information can be classified as (a) climatological, (b) current season data and forecasts, and (c) long-range climate outlooks (which cannot be achieved with the current state of meteorological understanding.)

3.6.1 Climatological Data

Range Management personnel expressed the need for access to climatological baselines of seasonal temperature, precipitation, and winds, for all available previous years; and for simple graphical tools to plot data and superimpose plots for different periods.

Specific needs were expressed for (a) NCDC-type, forest scale climatic summaries to correspond a given acreage allotment to a climatological annual precipitation zone (inches per year), and for (b) broad-scale maps of climatic normals and extremes as the basis for estimating soil moisture storage capacity.

3.6.2 Current Season Data and Forecasts

Needs were expressed for current, recent (last several weeks), and seasonal precipitation total for aid in vegetation condition assessment. Two-week forecasts are needed for decisions about permitted livestock grazing. Thirty-day forecasts and seasonal outlooks of temperature and rainfall are needed to drive yet-to-be-developed forage condition prediction models.

3.6.3 Long-Range Climate Outlooks

Currently, climatic data are plotted manually as x-y plots and searched visually to find historical analogues to the current year/season data. This manual ´pattern-matching´ approach is used by Range personnel to search for climatic trends and cycles in weather variables that affect range productivity. It is, they say, their only means of projecting range vegetation conditions for the current year and perhaps the next.

TABLE 3-5
RANGE MANAGEMENT

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Weather observations

Forestry/Fire Net

- Hourly (RAWS/P-RAWS)
- Daily (MANUAL, RAWS)

BLM IAMS

- RAWS

NOAA/NESDIS/NWS

- Hourly surface
- Precipitation rate/comulative amount
- Cumulative recent data
- Visual and IR satellite imagery and surface temperatures
- Cooperative observer network

NOAA/Climate Analysis Center

- Palmer Drought Index and components
- Crop Moisture Index and components

Weather forecasts

Surface weather

- Extended range forecasts (10 to 30+ days)
- Seasonal outlooks

NOAA/Climate Analysis Center

- Palmer Drought Index and components
- Crop Moisture Index and components

TABLE 3-5
RANGE MANAGEMENT (Cont.)

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Remotely sensed data

- Vegetation ´greenness´ (multispectral)
- Soil moisture (microwave)
- Snow cover/water equivalent (pan, multispectral and microwave)

National/regional scale data archives

- Once/day forestry/fire net manual observations
- Hourly forestry/fire net automatic (RAWS) observations

Online current local and national -scope shared files

- Forestry weather data/information, observed and predicted

Access to external weather information sources (climatology)

- National Forestry Weather Data Library (NFWDL)
- National Climatic Data Center (NCDC)
- NOAA Climate Analysis Center (CAC)
- BLM Initial Attack Management System (IAMS)
- SCS SNOTEL system
- USGS
- Regional/state Climatology offices

3.7 TIMBER MANAGEMENT NEEDS

The Timber Management -- related needs for operational weather information include:

- logging operations
- reforestation
- nursery activities
- seed orchard activities
- insect/disease control

Although many of the WIMS needs implied by these activities are already included in earlier Sections, Timber Management specialists have special needs for weather data/ information management. The needs fall into the following classes: (a) real-time weather data and short-range weather forecasts; (b) multiday to multiweek forecasts; (c) current season data; (d) climatological data; and (e) nursery support needs.

3.7.1 Real-Time Weather Data and Forecasts

Timber management personnel indicated widespread operational requirements for site-specific, one-day to several-day diurnal weather forecasts. The variables of interest are precipitation, winds, temperature, and relative humidity. The principal real-time applications are for:

- Administering logging operations. Fire danger, worker health and safety, road trafficability, vehicular access
- Reforestation. Start or stop contractor planting operations within available (e.g., two-week) schedule windows;

day-to-day decisions about feasibility of planting and adjustment of optimal planting hours

- Nursery and seed orchard operations. Predicting pollen flight paths, spraying, lifting, seed harvest.

3.7.2 Multiday to Multiweek Forecasts

Needs were expressed for forecasts on time scales of several days to several weeks. The variables needed are cumulative temperature (cumulative degree days or growth days), precipitation (cumulative rainfall), and winds. This forecast information has application to: lifting and replanting of nursery seedlings for optimal survival; pollen collection and controlled breeding; and cone collection in seed orchards. Other applications include: reviewing/evaluating prescribed burns; and predicting the dormancy of nursery seedlings.

3.7.3 Current Year/Season Data

The need exists for storing and accessing recent weather and snowpack data. Applications of current-year weather data include: reviewing recent season weather for adjustments of contract schedules and terms; analysis of seedling survival and growth; and review/evaluation of perscribed burning.

3.7.4 Climatological Data

Site-specific climatological data needs include extreme winds (for windthrow prediction models), precipitation and temperature (for scheduling of planting).

3.7.5 Nursery Operations Support Needs

In addition, however, a number of specialized WIMS data management needs were identified for nursery operations. These include:

- Data ingest from ´Omnidata´ data storage units -- variables include total radiation and photosynthetically active radiation; air and soil temperature; relative humidity; precipitation; wind speed and direction
- Interface with local nursery Bernouilli box data storage units
- Access to spreadsheet packages

TABLE 3-6
TIMBER MANAGEMENT

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Weather observations

Forestry/Fire Net

- Hourly (RAWS/P-RAWS)
- Daily (MANUAL, RAWS)

BLM IAMS

- RAWS

NOAA/NESDIS/NWS

- Hourly surface
- Precipitation rate/comulative amount

NOAA/Climate Analysis Center

- Palmer Drought Index and components
- Crop Moisture Index and components

Weather forecasts

NWS/NMC/RFC

- Severe weather/flood warnings and advisories
- 1 to 24 hours (site- and time-specific)
- 24 to 72 hours (site- and time-specific)
- Extended range forecasts (3 to 5 days, 6 to 10 days, 10 to 30 days, 30+ days)
- Seasonal outlooks

NOAA/Climate Analysis Center

- Palmer Drought Index and components
- Crop Moisture Index and components

TABLE 3-6
TIMBER MANAGEMENT (Cont.)

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Remotely sensed data

- Vegetation 'greenness' (multispectral)
- Soil moisture (microwave)
- Snow cover

National/regional scale data archives

- Forestry/fire net observations
- Hourly forestry/fire net automatic (RAWS) observations
- SCS snow course data

Online current local and national -scope shared files

- Forestry weather data/information observed and predicted
- SCS snow course data

Access to external weather information sources (climatology)

- National Forestry Weather Data Library (NFWDL)
- National Climatic Data Center (NCDC)
- NOAA Climate Analysis Center (CAC)
- BLM Initial Attack Management System (IAMS)
- SCS SNOTEL system
- USGS
- Regional/state Climatology offices

TABLE 3-6
TIMBER MANAGEMENT (Cont.)

SUMMARY OF WEATHER DATA/INFORMATION NEEDS
Active system capabilities *Responds to* • Event/exceedance-triggered RAWS transmissions • Weather warnings and advisories • Messages *Interfaces to* • Local automatic weather observing equipment • Local nursery data storage units Communications and cooperators • Federal agencies • State agencies

3.8 RECREATION NEEDS

The principal Recreation-related weather needs of the Forest Service are: (a) to create and disseminate short-range weather hazard forecasts in real-time; and (b) to distribute climatological weather data for public recreation planning.

3.8.1 Real-time Weather Data, Forecast and Information Needs

Weather hazards alerting. There exists a widespread need for an active system to acquire and deliver hazardous weather warnings. Potential weather dangers to recreational users of Forest Service lands include avalanches, winter storms (low temperatures, heavy snow), spring flash flooding, lightning, and high winds. A need exists to create and relay timely weather hazard forecasts and warnings to skiers and other winter recreationists. In particular, the need to create and disseminate avalanche prediction/warnings has grown greatly with the increased recreational use of the Forests in the winter. Similarly, the need was expressed for access to ALDS lightning data, and a means of providing real-time lightning warnings to recreationists in improved recreation sites.

WIMS should provide the capability to distribute these forecasts and warnings quickly to ranger and guard stations, and via other suitable links to local public access terminals or message services.

Snow Conditions. Winter recreation-related real-time weather information needs include (a) data on areal snow distribution, depth, surface condition, water content and (b) easy ways to disseminate such information quickly.

In common with many other activities, Recreation has needs for short-range (1-5 day) forecasts on the scale of a state climatic unit.

3.8.2 Climatological Data Needs

Recreation specialists need climatological data for planning, operations, and public information. WIMS should assist in accessing the following climatological data sets:

- Climatological summaries of monthly temperature, precipitation, and snowpack data for a given region. There is a need for electronic access to climatic summaries to make it easier to develop and update climatological information for inclusion on trail maps and other vacation planning literature
- Climatological summaries of monthly river/streamflow. Users need access to the sources of historical streamgage data, e.g., the U.S. Geological Survey (USGS), the Soil Conservation Service (SCS), state agencies (for example, data from the remote automatic streamgage monitoring networks operated by the California Water Resource Boards), and the National Climatic Data Center. As above, WIMS should provide facilities to automate and store selected portions of these data records.
- Hourly records of sky condition, visibility, transport winds to assess baseline visibility conditions and manmade impairment of scenic vistas in Forest Service lands
- Statistical information on avalanche weather and related predictors

TABLE 3-7
RECREATION

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Weather observations

Forestry/Fire Net

- Precipitation, winds, temperature

BLM IAMS

- ALDS

NWS/RFC

- Precipitation rate/cumulative amount
- Severe rainfall/rain-on-snow observations
- Cooperative observer network

Weather forecasts

Surface weather

- Severe weather/flood warnings and advisories
- Avalanche warnings
- Freeze/thaw elevation line
- 1 to 5 day "public service" forecast
- 0 to 24 hours (site- and time-specific)
- 24 to 72 hours (site- and time-specific)
- Extended range forecasts (3 to 5, 6 to 10, 30+ days)

Site specific weather briefings

- Severe temperatures
- Extreme winds
- Heavy precipitation
- Comfort Index

TABLE 3-6
RECREATION (Cont.)

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

National/regional scale data archives

- Snow course and stream flow data/information

Online current local and national -scope shared files

- Forestry weather narrative forecasts and data
- State, USGS and SCS snow course/stream flow files

Access to external weather information sources (climatology)

- National Forestry Weather Data Library (NFWDL)
- National Climatic Data Center (NCDC)
- NOAA Climate Analysis Center (CAC)
- BLM Initial Attack Management System (IAMS)
- SCS SNOTEL system
- USGS
- Regional/state Climatology offices

Active system capabilities

Responds to

- Weather warnings and advisories
- Avalanche forecasts and warnings
- Messages

Communications with cooperators

- Federal agencies
- State agencies

3.9 PEST MANAGEMENT NEEDS

We investigated weather needs for Forest Service pest management. These are the needs specifically identified for us:

- Forecast weather information. The need exists for short-to medium range forecasts of site-specific dispersion conditions (mixing height, surface winds, temperature, stability) for airborne dispersal of pesticides. Site specific degree-days forecasts corrected for altitude and aspect are needed to predict insect and vegetation development stage.
- Climatological information. Access to climatological data files is needed to run yet-to-be-developed models of insect population dynamics.
- Future needs. Users identified possible future needs for high resolution satellite surface temperature data to model insect and vegetation development, and multispectral imagery for observations of vegetative ´greenness´.

TABLE 3-8
PEST MANAGEMENT

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Weather observations

Forestry/Fire Net

- HOURLY (RAWS, P-RAWS)

BLM IAMS

- HOURLY RAWS

NOAA/NESDIS/NWS

- Hourly surface
- Twice/day upper air temperatures and winds to 500 mb
- Precipitation rate/cumulative amount
- Satellite visual and IR cloud imagery
- Satellite IR surface temperatures
- Cooperative observer network

NOAA/Climate Analysis Center

- Palmer Drought Index and components
- Crop Moisture Index and components

Weather Forecasts (site- and time-specific

Surface winds, temperatures, cloud cover, precipitation

- 0 to 3 hours
- 3 to 24 hours
- 24 to 72 hours

TABLE 3-6
PEST MANAGEMENT (Cont.)

SUMMARY OF WEATHER DATA/INFORMATION NEEDS

Pesticide dispersion

- Stability (lifted index), 12 to 24 hours
- Low level winds, 12 to 24 hours
- Upper air winds, temperatures to 500 mb, 12 to 72 hours

Remotely sensed data

- Vegetation ´greenness´
- Profiler data

National/regional scale data archives

- Once/day forestry/fire net manual observations
- Hourly forestry/fire net automatic (RAWS) observations

Online current local and national -scope shared files

- Forestry weather narrative forecasts, including smoke dispersion guidance

Access to external weather information sources (climatology)

- National Forestry Weather Data Library (NFWDL)
- National Climatic Data Center (NCDC)
- BLM Initial Attack Management System (IAMS)
- Regional/state Climatology offices

Communications with cooperators

- Federal agencies
- State agencies

3.10 FISHERIES AND WILDLIFE NEEDS

We investigated weather needs of Fisheries and Wildlife specialists. The only weather-related needs specifically identified for us were the following:

- Predictions of warm rain on snow, to allow real-time action to preserve fisheries stock
- Seasonal and yearly cumulative precipitation, on the scale of a basin/subbasin, to estimate erosion effects on harvested forest areas and on fisheries (siltation)
- Predictions of stream flow levels, focusing on spawning habitats.

3.11 FORESTRY WEATHER FORECAST SERVICE NEEDS

By formal agreement, the Forest Service (and cooperating federal and state land management agencies) are obligated to provide and deliver weather observations and related data to the National Weather Service. In turn, the NWS is responsible for delivering forecasts and related guidance to the agencies. AFFIRMS has features that serve this arrangement in all but one very important way: it is not directly accessible from AFOS, the NWS´ operational weather information management system.

3.11.1 AFFIRMS Features for WIMS

Users voiced the need for WIMS to preserve the features in AFFIRMS that were developed to facilitate preparation and distribution of routine forecast tasks.

- Assignment of forestry/fire-net weather stations to "forecast zones" (the FWXZ command)
- Assignment of forestry/fire-net weather stations to temporary groups (the STOW command)
- Retrieval of observations by standard and user-specified groups of forestry/fire-net weather stations (the DSPW OBS command and the REG(ion), STAT(e), C(ou)NTY, (fire weather) ZONE, (individual station) ID, LIST (of stations), (administrative) UNIT, and Special Interest Group (SIG) display scope operands)
- Conversion of relative humidity to dew point (SET DWPT command)
- Computation of means and medians of weather parameters reported by forecaster-specified groups of stations (the SET MEAN and SET MEDIAN commands)
- Options of entering forecasts with "trends" (the ZONE command) or with "numerical" values (the FCST command)
- Access to all RAWS hourly data (the RAWS, DSPW, and DSPR commands)
- Development, storage, and execution of "macros" (the FILE MAKE and FILE READ commands)
- Addition of headings to output displays (the FILE MAKE command and* string designator)
- Entry of narrative forecasts (the FILE MAKE command)
- Dispatch of spot forecasts (the POST command)

3.11.2 Other Feature for WIMS

In addition, forecasters voiced needs for WIMS features and capabilities not provided by AFFIRMS. These are, for the most part, already identified in Sections 3.1 and 3.2, but a few are worth recalling here:

- Field addressable data entry forms for making routine and "spot" forecasts
- Access to BLM RAWS hourly data (beginning in 1988, these data will not be available through AFFIRMS)
- Access to ALDS data (currently available through AFDS)
- Direct access to WIMS via AFOS (via AWIPS/NOAAPORT in the mid-1990s).
- Easy access to the NFWDL to download data sets
- Easy access to fire management software, e.g., FIREFAMILY

However, all of these stated WIMS needs to support NWS forestry weather forecasters might conceivably be much different or not be requirements on WIMS at all, if (a) in the 1990's AWIPS/NOAAPORT environment, the NWS will no longer continue to provide Fire/Forestry weather support, and/or (b) the Forest Service subsequently elects to procure its needed fire/forestry weather forecast service support by other means, e.g. via some combination of an inhouse capability and one or more private-sector weather forecast services.

4. IMPLICATIONS FOR THE OVERALL ARCHITECTURE OF WIMS

The overall architecture of WIMS should reflect the broad range and variety of its potential users:

- Fire and Aviation Management operations staff
- Non-Fire (e.g. Timber, Hydrology, Engineering, etc.) operations staff
- NWS or private-sector fire weather forecasters
- Administrators
- Maintenance Personnel (hardware and software)
- Trainees

It appears from this indepth User Needs assessment that, except for Fire and Aviation Management, and Research, Forest Service personnel are by and large not very knowledgeable about weather data resources or current technology for management and display of weather information. Above all, the system architecture must ensure that WIMS is easy to use, easy to learn, and easy to modify and extend, so that Forest Service users and other potential users of WIMS may quickly develop confidence in using the system, and in the new tools it offers for making weather-sensitive decisions.

Most WIMS users have very similar requirements for system ´ease-of-use´ and ´ease-of-learning´ -- that is, for a powerful but supportive user interface. The heart of the WIMS software architecture should, therefore be a User Interface

Management System (UIMS). It will package the system's user interface capabilities and interface with other generic system components.

Seen from the top level, the UIMS is envisioned functionally as three major subsystems: the Input/Output (I/O) Manager; the User Interface Services Component; and the Intelligent Controller.

The I/O Manager subsystem will support such I/O activities as screen forms (e.g., field-addressable data templates), textual reports, business and special graphics requests, electronic message, mail and word processing, as well as the WIMS internal protocols and information formats.

The User Interface Service Component, which will be largely invisible to the end-user, will include such functions as: system initialization, system recovery, trouble detection and resolution, status reporting, message handling (encode/decode), device control, screen management (e.g., windowing, roll, scrolling, etc.), training and 'help' facilities, technique development tools, and the maintenance personnel interfaces.

The Intelligent Controller subsystem manages the interactive dialogue with the user, by interpreting process plans. It uses menus, command languages and the like to drive the user through the proper use of the system and the applications product sets. It serves as the foundation for the integrated workstations for WIMS, and manages the job activities, scheduling and security of WIMS users. It interfaces with the following generic modules: the Network Transaction Management Subsystem; the Data Base Management Subsystem; the Virtual Terminal Interface Subsystem; the Applications Management

Subsystem; the Knowledge Data Base; the Product Dictionary; the Guide Model; and the Vendor Supplied Operating System.

The Network Transaction Management Subsystem controls message transactions in a distributed environment that may contain heterogeneous computers. For the Forest Service as a whole, this function is provided by the PDN via the Telenet packet switching system. However, there are stated WIMS user requirements for interface to other packet switching services, and for radio (voice) communications. Because TELENET does not fulfill these needs, it appears that WIMS itself will have to provide these specific capabilities.

The Data Base Management Subsystem offers a consistent and easy means for user applications to access and maintain information, by use of neutral data definition and data manipulation languages. The DBMS performs all the necessary management control, transformations and acquisition procedures.

The Virtual Terminal Interface Subsystem provides features and protocols for a variety of text, graphic and image terminals. These specific terminal characteristics are mapped against the virtual (i.e. WIMS internal protocol) characteristics, by way of software modules and/or hardware circuitry. A software utility supports the definition, editing and deleting of data that describe terminal types to interface with WIMS.

The Applications Management Subsystem contains all the system, application and dictionary libraries that hold the application algorithm, mathematical and statistical utilities, and all the modules (subroutines) for all application tools that support various discipline-related functions. These libraries are related to a specific function by way of the Knowledge Data Base.

The Knowledge Data Base is necessary for the easy building of user menus and help functions. It defines each application available to the user, contains the 'knowledge' about the functions that an expert would perform, points to the information that will be needed from the application data base, and suggests alternative application tools for the task. In effect, it helps the user to decide how to best use the system. In time, it could evolve into an expert system for user decision assistance, if the rules based on the data infer unique actions.

The Product Dictionary contains the definitions of the software components that comprise the systems software. The product dictionary maintains a definition of the system architecture, including all the program modules, inputs and outputs, as well as all the data types that are defined in the applications data bases. The Product Dictionary also provides system documentation in a machine-readable format and assists the maintenance and extension of the system.

The Guide Model controls the process flow. It provides a suggested approach (and possibly a standard approach) to the most cost-effective solution strategy for the user's problem, as well as the progression of steps (or processes) to carry it out. It defines the scheduling and sequencing of activities that must be performed, as well as the tools that correspond to each activity. It assists the user to make optimal use of the system for decision assistance.

5. ISSUES FOR FURTHER CONSIDERATION

The interview and needs analysis process has bounded many of the user-identified requirements for weather information management. At the same time, however, it has brought into sharper focus a number of existing unresolved issues and surfaced some new ones. This section identifies a number of key issues with important implications for WIMS, issues that need better resolution by the Forest Service.

5.1 LACK OF EXPERIENCE USING WEATHER INFORMATION

The interviews reaffirmed the fact that, outside of the Fire and Aviation Management staffs, Forest Service personnel by and large do not know much about how weather information can help in making better decisions for their respective activities, and they have little to no experience with modern weather information management tools. Even available resources such as portable RAWS aren't widely recognized.

Many potential customers for forestry weather information cannot articulate their weather needs, largely because they don't have an operational concept for using weather, and often don't realize fully the decision value of such information for their activities. Even those current users who depend greatly on weather information do not now have ways to quantify its value.

The poor use of forestry weather for decision making is, among other things, a complex multicomponent training problem, and like any such problem the solution demands an ´integrated systems engineering approach´. To raise their consciousness and confidence in the decision value of weather (and so increase the user ´market´ for WIMS), potential users need much better weather awareness, appropriate hands-on training, and affordable access to the right weather information management tools. Adequate training presupposes reliable training data, well-designed training materials and knowledgeable instructors, effective user software tools, good documentation and other facilities.

5.2 INADEQUATE FORESTRY WEATHER FORECAST SUPPORT

Many of the most stringent WIMS weather needs voiced by users arise because they do not feel they are receiving the basic forecast support they should be getting from others. Some users say they have serious reservations about the quality and consistency of forestry weather forecast support provided by the National Weather Service. These users typically want WIMS to provide a great deal of weather information, data products, and tools to manipulate information (for example, surface and upper air observations, forecast maps, satellite visible and IR cloud imagery). They want to do for themselves what they aren´t getting from the NWS. In full fairness, however, it should be emphasized that other users are perfectly happy with NWS support. The problem appears to be regional, not universal.

In conducting the interviews we tried to get respondents to distinguish between their perceived need (e.g, a stated need for animated sequences of surface frontal positions) versus the real (but often unstated) need (e.g., the operational need for accurate hourly forecasts of significant wind shifts at a project site). A demonstrated commitment to provide adequate, user-customized forestry weather forecasts might well significantly reduce the 'perceived' needs identified explicitly in this study.

Many of those interviewed expressed anxiety about the possibility that budgetary constraints may cause NWS to reduce its resources for the Fire Weather program. They are afraid of being left 'high and dry' without knowledgeable forestry weather forecast support, and yet without the means and tools to make do for themselves. As noted in the 1986 National Wildfire Coordinating Group report on Fire Weather Services, alternatives are now being sought. For example, agencies in Florida are experimenting with fire weather support provided by a private weather service.

As the Forest Service is well aware, the question of long-term NWS support to the Fire Weather program has numerous important spinoffs. For example, if the NWS no longer provides ATMUs and onsite fire weather forecaster field support for wildfires or prescribed burns, who will support this function? Does this mean that WIMS would have to provide a fully mobile or portable capability? Would access to NWS observational and forecast products from the field then be a requirement for WIMS itself? Who would receive such support and by what means? Who would pay for it and how much? These and other issues for the Forest Service will necessarily influence the WIMS design.

Questions of relative cost for NWS-based forestry weather support vs. non-NWS forestry weather support (e.g. from the private-sector or internal to the Forest Service) will be explored in Task 3 to the extent that available information will allow.

5.3 `WILLINGNESS TO PAY´ IS NOT RESOLVABLE NOW

We were surprised to find that of the many Forest Service staff we interviewed, only a handful had any firm idea about how much weather information was actually costing them now. This may be the result of the recent change of AFFIRMS contractor. It appears that the new lower effective costs for AFFIRMS services aren´t yet known to many Regional Fire and Aviation Management staff. Our interview records show that a few offices indicated expenditures for weather data from the NCDC or from a commercial weather information vendor. Many interviewers are relying on local "TV weather" broadcasts for their weather information.

Interviewees resisted indicating for the record (or for that matter, even guessing at) what they might be ´willing to pay´ for weather information and services. (This is not surprising, because they have no way of quantifying the value of weather information.) The overriding problem seems to be the uncertainty in their own agency budgets, staffing levels and other resources. Nobody is certain of the resources available next year or beyond, relative to other urgent priorities and unknown outyear budget ceilings, so nobody would even guess (much less commit to) how much he might be willing to spend in the future for weather information. (Perhaps some of the managers who were unavailable for interviews could have provided more guidance). What information we did obtain is fragmentary and non-committal. We judge it unreliable.

With so many decisions yet to be taken about the ultimate shape, scope, capabilities and costs of WIMS and its products, services, and delivery mechanisms, the interviewers were not able to quote 'cost to provide' figures or ranges to prospective users. Users will not speculate about what they might be willing to pay for WIMS, without first seeing a lot more 'hard' information about the system and its assured functionality. In retrospect, it was premature to expect potential FS users of WIMS to identify their 'willingness to pay' for WIMS capabilities and services at this very early point in the WIMS definition/design process. We recognized the 'chicken and egg' nature of the problem, but we could not resolve it at this time. Once the design of WIMS is reasonably well established at the end of Task 3, the Forest Service may wish to present the adopted WIMS design to selected interviewees and give them the opportunity to 'kick its tires' (so to speak) before asking what they would be 'willing to pay'.

Another aspect of the 'willingness to pay' problem, which only the Forest Service can resolve, is how the costs of WIMS are to be apportioned among different classes or levels of users. How much 'user functionality' should WIMS offer? How many features are to be included in the 'standard' package? How many features will be 'optional'? Will much of the system be provided on a 'take or pay' basis? In performing Task 3, we will need guidance from the Forest Service.

5.4 THE NON-WEATHER BOUNDARIES OF WIMS ARE UNCERTAIN

Our assessment, based on information presented to us late in the needs assessment process, assumes that the

Forest Service Data General system, not the WIMS per se, will provide the needed non-weather administrative functions now provided by AFFIRMS. Such functions include: electronic message/bulletin board capabilities; intersite data communications and gateways to external systems; system-wide data security; software configuration management; account validation, usage, and billing; and numerous other non-weather functions. If such a partitioning of overall system functionality into 'WIMS -weather' and 'non- WIMS, non-weather' elements cannot be assumed, then the administrative-type needs will have to be added to those presented here for WIMS. Whether these functions should lie 'inside' or 'outside' WIMS will depend upon their impacts on local Data General Systems. This determination will be made during Tasks 2 and 3.

5.5 THE 1991 TIME CONSTRAINT IMPLIES AN EXPANDIBLE ARCHITECTURE FOR WIMS

The Forest Service intends to deploy WIMS in the 1991 time frame, years before the expected completion and verification of the next generation integrated fire behavior/fire danger rating system. The responsible researchers at the (Missoula) Intermountain Fire Sciences Laboratory are only now beginning work on their new Research Work Unit Description. They are more than a year away from beginning to converge on the form and scope of the integrated system, much less its specific requirements for weather information. Their requirements for weather data and information products cannot be specified at this time for the post-1991 WIMS.

Even more to the point, by 1991 NWS' massive new AWIPS/NOAAPORT system, which is intended to create and distribute all of NWS' weather products and forecasts in the 1990s, will be far from fully implemented nationwide, especially in more remote, less populous regions of the nation. A 1991 startup date for WIMS is also well before the complete implementation of the national NEXRAD precipitation radar network. And finally, in 1991 the NWS will still be in the full throes of implementing its own massive program of "Modernization and Associated Restructuring". The NWS' emphasis for operational meteorological and hydrological services will shift from centrally-issued synoptic-scale forecasts and guidance, to fine-resolution regional and local-scale severe products created at local NWS Warning and Forecast Offices. In this new era of local severe-weather focus, the fate of the Fire Weather program is unclear.

It is hard to predict the specific final shape for any of these important operational and research and development programs. We may be certain, though, it will take time to properly exploit these new modeling and weather information resources for WIMS, and to test them adequately in controlled operational scenarios.

We think that the initial 1991 fielded version of WIMS will necessarily focus primary on the needs of the Fire and Aviation Management groups, because, as yet, most of the other Forest Service activities have little if any operational concepts for the use of weather. In effect, the baseline implementation of WIMS would recreate all the important functionality of AFFIRMS today, with many obviously needed additions and extensions. Where solid operational concepts for weather information use already exist, e.g., for Watershed, Hydrology, and Air Resource activities, the initial version of WIMS could also offer direct support.

In any event, the baseline WIMS could certainly provide an efficient, economical and supportive interactive environment for many of the general systems needs identified in Section 3.1 -- modern user support facilities for interactive data editing, automated data screening/quality control, tools for modeling, data display and analysis, automatic alert, easy interfaces to external data sources, and many other system-level features.

At the same time, we do not think it is possible to see clearly enough into the future to identify all the forthcoming needs of the 1990s, much less to design now the ′full′ functionality WIMS that will be needed to serve the Forest Service through the late-1990s. The 1990′s technologies for Geographic Information Systems, for interactive display and data management, and so forth, are likely to be very different from those we might now imagine. We would recommend against locking into a 1988 hardware/software architecture for the eventual full system. Rather, at all times WIMS should have as open an architecture as possible, so that as the new sources of information are introduced (together with the new models and techniques to exploit them), the basic functionality of WIMS can be preserved and expanded to more powerful hardware/software environments in an expanded WIMS.

5.6 WIMS INTERAGENCY PARTICIPATION CANNOT BE TAKEN FOR GRANTED

So far as we know, there is no formal national-level effort underway to coordinate the Forest Service′s WIMS development plans with the ongoing system development plans of the BLM and the NPS for weather and environmental information management. *These other programs are well along on their own aggressive multiyear development trajectories*. BLM, for example, has already begun planning for their next-generation IAMS, and NPS has already invested more than 25 person years in software development for its own fire management/organization information system and GIS. BLM has hinted they would like to reduce their dependence on AFFIRMS soon, and NPS is looking for an alternative source of fire weather/fire danger information.

The USDI agencies are not waiting for WIMS.

Unless WIMS will accommodate the special needs of these agencies (e.g. alternative virtual terminal accesses, other telecommunications networks, shared data storage, etc), it is unlikely that BLM, NPS or others will 'sign up' for WIMS. For example, if the Forest Service intends to share data and information with the NPS, then WIMS must interface with the NPS system in some mutually acceptable manner. If the Forest Service wants to ensure BLM and NPS participation in WIMS, it should begin high-level technical discussions with these agencies as soon *as possible, to develop an interagency concept and plan for the expansion of WIMS*.

APPENDIX A

COMBINED LIST OF WIMS INTERVIEWEES

(Personal Visits and Telephone Interviews)

USDA FOREST SERVICE

Washington Office

Administration

Computer Sciences and Telecommunications

- Clyde Shumway, Director
- Steve Werner, Group Leader, Telecommunications Management
- Don Beardshear, Telecommunications Management Specialist

National Forest Systems

Timber Management

- Dick Miller, Forester

Wildlife and Fisheries Management

- Leslie Welden, Fisheries Biologist
- Michael Dombeck, Fisheries Biologist

Range Management

- Gerald Henke, Range Conservationist

Watershed and Air Management

- Jim Byrne, Air Program Manager
- Richard Fisher, Air Specialist, Ft. Collins, Colorado
- John Nordin, Soil Specialist
- Rhey Solomon, Hydrology Program Manager
- Roger Tucker, Weather Program Manager
- Bonnie Mason, Meteorologist

Land Management Planning

- Lloyd Lundeen, Land Management Planning Staff

Research

Forest Fire and Atmospheric Sciences

- William Sommers, Director
- Steve Sackett, Research Forester (Riverside, California)

Timber Management

- Nelson Loftus, Director

Forest Environment

- Richard Cline, Soil Scientist

State and Private Forestry

Fire and Aviation Management

- Bill Baden, Director for Logistics Support (Boise, Idaho)
- John McKelvey, Mobilization (Boise, Idaho)
- Tom Rios, Intelligence (Boise, Idaho)
- Linda Knowlton, Computer Systems Manager
- Roger Bradshaw, Computer Programmer/Analyst (Boise, Idaho)

Forest Pest Management

- John (Jack) Barry, Pesticide specialist (Davis, California)

Northern Region (R1)

Regional Office, Missoula, Montana

Aviation and Fire Management

- Jim Mann, Director
- Troy Kurth, Fire Planning and Development
- Ron Hendrickson, Regional Coordinator

Engineering

- Jim Hogan, Assistant Director of Engineering for Technical Support
- Brad Miller, Structural Engineer

Cooperative Forestry and Pest Management

- Jack Thompson, Director
- Jed Dewey, Entomology Group Leader

Timber Management

- Bob Schranks, Reforestation Specialist

Range, Air, Watershed and Ecology

- Ron Russell, Water Rights and Air Quality

Recreation, Wilderness, and Lands

- Homer Bowles, Recreation Management

Kootenai National Forest, Libby, Montana

- Richard Kimberlin, Fire Staff Officer

Clearwater National Forest, Orofino, Idaho

- Gary Meyer, Fire Staff Officer

Flathead National Forest, Kalispell, Montana

- David Bunnell, Fire Staff Officer

Rocky Mountain Region (R2)

Regional Office, Denver Colorado

Aviation and Fire Management

- Tom Quinn, Director
- Al Roberts, Program Leader, Prescribed Fire and Fuels Management
- Dennis Haddow, Program Leader, Air Quality Management
- Ron Bell, Program Leader, Aviation Management
- Darrell Smith, Regional Coordinator

Routt National Forest, Steamboat Springs, Colorado

- Jerry Schmidt, Supervisor

White River National Forests

- Curtis Bates, Deputy Forest Supervisor

Southwestern Region (R3)

Regional Office, Albuquerque, New Mexico

Aviation and Fire Management

- Jimmy Hickman, Director
- John Burton, Assistant Regional Coordinator

Range Management

- Darrol Harrison, Assistant Director for Range Administration

Timber Management

- Marlin Hughes, Director

Watershed and Air Management

- Noel Larson, Director
- Doug Shaw, Assistant Director
- Toby Hanes, Hydrologist (Air Resources Management)

Coronado National Forest, Tucson, Arizona

- John Roberts, Fire Staff Officer

Intermountain Region (R4)

Regional Office, Ogden, Utah

Range and Watershed Management

- Peter Stender, Regional Hydrologist
- Clif Benoit, Air Quality, Water Rights and Water Resource Coordinator

Aviation and Fire Management

- Pat Kelly, Regional Fire Coordinator

Boise National Forest, Boise, Idaho

- Chuck Sells, Forest Dispatcher

Payette National Forest, Boise, Idaho

- Gene Benedict, Fire Staff Officer

Pacific Southwest Region (R5)

Regional Office, San Francisco, California

State and Private Forestry

- Tom Fulk, Assistant Regional Forester

Fisheries and Wildlife
- Randall Long, Assistant Regional Forester

Recreation, Wilderness and Cultural Resources
- Gary Plisco, Group Leader, Management and Planning

Aviation and Fire Management
- Dick Harrell, Regional Fuels Specialist

Plumas National Forest, Quincy, California
- John Maupin, Fire Staff Officer

Pacific Northwest Region (R6)

Regional Office, Portland, Oregon

Aviation and Fire Management
- Val Descamps, Regional Meteorologist
- Ken Snell, Operations Analyst

Timber Management
- Wendall Jones, Director

Fisheries and Wildlife
- Hugh Black, Director

Engineering
- Tim Rogan, Director
- Phil Hirl, Assistant Director for Transportation Management
- Chuck Tietz, Network Manager

Recreation Management
- Lyle Laverty, Director

Management Systems
- Bill Funk, Director

Mt. Hood National Forest
- Gordie Schmidt, Fire Staff Officer
- Don Carlton, Fuels Management Specialist
- Donna Lamb, District Ranger, Zigzag Ranger District

Siuslaw National Forest, Corvallis, Oregon

- Larry Mahaffey, Assistant Fire Staff Officer

Okanogan National Forest, Okanogan, Washington

- Phil Gum, Fire Staff Officer

Southern Region (R8)

Regional Office, Atlanta, Georgia

Aviation and Fire Management

- Bobby James, Program Leader, Suppression
- George Martin, Program Leader, Fuels and Prescribed Burning

Soil, Water and Air Management

- Keith Grest, Director
- Keith McLaughlin, Program Leader, Air Resource Management

Timber Management

- Olen Aycock, Reforestation Specialist

Engineering

- Bruce Meinders, Director
- Jim Milner, Assistant Director for Facilities and Energy Management
- Douglas Scholen, Materials Engineer
- Dick Jones, Structural Engineer
- Bill Clerke, Remote Sensing Specialist

Forest Pest Management (Southeast Area)

- Harvey Toko, Director
- Dan Brown, Pathologist
- Larry Barber, Entomologist, Asheville, North Carolina

National Forests in North Carolina, Asheville, North Carolina

- Fred Foster, Fire Staff Officer

National Forests in Florida, Tallahassee, Florida
- Hunter Wistrand, Fire Staff Officer

National Forests in Alabama, Montgomery, Alabama
- Don Shumaker, Fire Staff Officer

Ozark - St. Francis, National Forest, Russellville, Arkansas
- Jack Kriesel, Assistant Fire Staff Officer

Francis Marion National Forest, Moncks Corner, South Carolina
- Willie Mims, Fire Management Officer, Witherbee Ranger District

National Forests in Mississippi, Jackson, Mississippi
- Lynn Marsalis, Fire Staff Officer

Eastern Region (R9)

Regional Office, Milwaukee, Wisconsin

Aviation and Fire Management
- Ed Kautz, Acting Director
- Len Mason, Regional Coordinator

Timber Management
- Ken Shalda, Assistant Director for Timber Sales
- John Murphy, Geneticist and Reforestation Specialist

Hiawatha National Forest, Escanaba, Michigan
- Loren Woerpel, Fire Staff Officer

Monongahela National Forest, Elkins, West Virginia
- Barry Edgerton, Forest Hydrologist and Air Resource Specialist

Superior National Forest, Duluth, Minnesota
- Bob Berrisford, Forest Hydrologist and Air Resource Specialist

White Mountain National Forest, Laconia, New Hampshire
- Randy Ferrin, Forest Hydrologist and Air Resource Coordinator

Alaska Region (R10)

Regional Office, Anchorage, Alaska

Aviation and Fire Management

- Ginger Brudevold, Assistant Regional Coordinator

Intermountain Research Station

Intermountain Fire Sciences Laboratory, Missoula, Montana

Fire Behavior: Fundamentals and Systems Development

- Dick Rothermel, Project Leader
- Pat Andrews, Mathematician
- Don Latham, Research Meteorologist
- Larry Bradshaw, Contractor

Fire Effects

- James K. Brown, Project Leader

Rocky Mountain Research Station

Station Headquarters, Ft. Collins, Colorado

Atmospheric Deposition

- Douglas Fox, Project Leader

North Central Research Station

Forestry Sciences Laboratory, East Lansing, Michigan

Fire Management Planning for the Northeastern United States

- Al Simard, Project Leader
- Don Haines, Research Meteorologist
- Bill Main, Computer Specialist
- Linda Donahue, Sociologist

Pacific Southwest Research Station

Riverside Forest Fire Laboratory, Riverside, California

Long Range Forecasting for Fire Severity

- Francis Fujioka, Project Leader
- Morris McCutchen, Research Meteorologist (Retired) Fire Management Planning and Fire Management
- Lucy Salazar, Project Leader

Southeastern Research Station

Southern Forest Fire Laboratory, Macon, Georgia

Forestry Weather Data Systems

- Robert (Bob) E. Burgan, Research Forester
- Ken Forbus, Research Meteorologist
- Lee Lavdas, Research Meteorologist
- Brian Donnelson, Research Meteorologist

National Seed Tree Laboratory, Macon, Georgia

Stand Establishment of Loblolly Pine

- David Bramlett, Project Leader

Northeastern Area State and Private Forestry

Forest Pest Management, Broomall, Pennsylvania

- Peter Orr, Assistant Director

Fire Protection

- Jack Horton, Staff Specialist for Fire Planning

STATES

Alaska Division of Forestry, Anchorage, Alaska

- Frenchy Malott, Operations Forester (Fire)

Georgia Forestry Commission, Macon, Georgia

- Wesley Wells, Fire Control Chief
- George Rippen, GFC Meteorologist (programmer/system manager)

Minnesota Department of Natural Resources St. Paul Minnesota

- George Meadows, Fire Management Specialist

Montana Department of Lands, Missoula, Montana

- Ed Mathews, Chief of Fire Control

Oregon State Department of Forestry, Salem, Oregon

- Mike Ziolko, Meteorologist (Smoke Management)

California Department of Forestry

North Coast Region, Santa Rosa, California

- Bill Imboden, Region Chief

Southern California Region, San Diego, California

- John Gray, Resource Forester, San Diego Ranger Unit

Division of Fire Control, Sacramento California

- Don Perkins, Assistant Chief for Fire Planning
- Wayne Mitchell, Fire Behavior Analyst

Division of Resources, Sacramento California

- Dale Wierman, Resource Forester, Air Quality Staff Specialist

Florida Division of Forestry, Tallahassee, Florida

- Charles Maynard, Assistant Fire Control Chief

NATIONAL WEATHER SERVICE

WSFO, Minneapolis, Minnesota

- Ron Willis, Deputy MIC
- Bryan Paulson, Fire Weather Program Leader

WSFO, Columbia, South Carolina

- Jerry Harrison, Lead Fire Weather Forecaster

WSFO, Boise, Idaho

- Chris Hill, Deputy MIC
- Steve Brown, Lead Fire Weather Forecaster
- Carl Gorski, Fire Weather Forecaster

WSFO, Missoula, Montana

- Dave Goens, Lead Fire Weather Forecaster

WFO, Riverside, California

- Nancy Dean, Lead Fire Weather Forecaster

WFO, Salem, Oregon

- Terry Marche, Lead Fire Weather Forecaster

BUREAU OF LAND MANAGEMENT

Washington Office

Fire Management

- Jay Thietton, Fire Specialist
- Roger Trimble, Assistant Director

National Interagency Fire Coordination Center, Boise, Idaho

- Jack Wilson, Director
- Roy Percival, Assistant Director
- Ken Reninger, Branch Chief, Remote Sensing and Data Management
- Steve German, IAMS Program Manager

New Mexico State Office, Albuquerque, New Mexico

- Cyndie Hogg, Assistant Dispatcher

NATIONAL PARK SERVICE, BOISE, IDAHO

- Dave Butts, Chief, Fire Management
- Rod Norum, Fire Management Specialist
- Scott Erickson, Fire Management Specialist
- Judy Zuckert, Fire Information Specialist

BUREAU OF INDIAN AFFAIRS, BOISE, IDAHO

- Jim Schneider, Fire Management Specialist

FISH AND WILDLIFE SERVICE, BOISE, IDAHO

- Walt Okamoto, Fire Management Specialist

APPENDIX B

INTERVIEW GUIDE FOR WIMS USER NEEDS ASSESSMENT STUDY

1. QUESTIONS FOR ALL INTERVIEWEES

Overview Questions

- What job do you do and how do you do it? Please take me through your operational tasks. Make sure I know what is done, the order and timing in which things are done, etc.
- What data/information is input to each function? Please tell me how much, when, where from, speed and amount (these are the critical factors).
- What are the products (reports,data, maps, etc) that are output from each function? Please tell me how much, how many, how often, speed and deadlines, if any.
- Who are your users?
- What are the constraints on how you do each function? Please tell me how you are constrained by your customer´s decision timelines, by availability schedules for input data/products, by required prior actions by others, by system usage, by time of day, environmental factors and other conditions.
- How do you see the functions of this office changing? What changes do you foresee between now and 1991? Between 1991 and 2000? What new kinds of weather-based products and other data/information will be needed? Which of the constraints already discussed will disappear? What new constraints do you anticipate?

- What are the primary tasks and subtasks of this office today?
- What is your daily schedule or sequence of activities?
  - How does your routine change during a fire weather alert?
  - How does your routine change during fire operations?
  - Do you have a checklist for your daily activities?
- How do you go about those activities?
- What training/experience is relevant to what you do?
- In which area(s) do you use weather data and/or information?
  - Fire Management: fire control, fire use (prescribed burning)
  - Fire Research and System Development
  - Engineering (design, maintenance)
  - Timber Management (herbicide and fertilizer application, reforestation)
  - Range Management (herbicide and fertilizer application, reclamation/improvement)
  - Forest Pest Management (pesticide application, disease and insect population/activity prediction)
  - Recreation (regulation of recreational areas, avalanche hazard prediction/warning, flash flood prediction/warning)
  - Wildlife and Fisheries Management
  - Watershed and Air Management (smoke management, Clean Air Act responsibilities, PSD, visibility protection, Air Quality Related Values)
  - Watershed Management

  - Air Operations (scheduling transportation, aerial surveys and photography, managing contract aircraft/crews, scheduling maintenance)
  - Land Management/Planning

What specific decisions are made in this office/staff group?

- Who makes those decisions?
- Which of those decisions are sensitive to weather? Directly? Indirectly? Previous weather? (e.g. cumulative precipitation)? Forecasted weather?
- Do some of the key functions or decisions happen ´on-site´ in the field?

Is ADP familiar in your work environment?

- Are you (your colleagues) comfortable with computers? Which kinds?
- Does someone else use a computer or terminal for you?
- In what form or forms do you supply or obtain information?

2. QUESTIONS FOR CURRENT USERS OF WEATHER DATA AND INFORMATION

Which data/images/information products do you now use?

- Checklist of weather data/imagery/product types
  - Narratives (bulletins/forecasts/advisories/fire danger ratings, etc.)
  - Observed and/or predicted weather
  - Climatology

  - Lightning
  - Other
- Checklist of non-weather data/imagery/information
  - Topography
  - Vegetation distribution, phenology, condition
  - Fuels distribution
  - Soils and soil moisture
  - Other items from National Wildfire Coordinating Group Working Team Survey Form (1984)
- Do you use ´current´ (real time) data?
  - How often needed?
  - With what lead times?
  - What is the source?
  - Spatial/temporal resolution?
  - Spatial coverage?
  - Representativeness?
  - Reliability, accuracy, precision?
  - Critical threshold or ceiling values/combinations?
  - Joint or conditional statistics?
- Do you use historical/climatological data?
  - Recent past data? How much? How many hours/days worth? From where? How many stations?
  - Historical data? How much? How many months/years worth? From where? How many stations?

From where, whom and how do you obtain weather data/images/products?

- Do you need capabilities to obtain/produce/transmit data or products in the field during fire operations? Which ones? How much? How often? In what forms? From/to where?
- Do you retrieve or store weather data/images/products? What kinds? How much? How frequently? To/from an external database or library? Is your present method adequate?
- Do you need new or additional data/information sources and methods for analyzing those data?
  - Hourly RAWS data?
  - Real-time access to the NFWDL database/models?
  - Real-time access to FIREFAMILY?
  - Satellite imagery? NOAA AVHRR? GOES? LANDSAT? SPOT?

Do you interpret/process weather data to produce a secondary product used for decisionmaking?

- What sorts of products?
  - Fire-danger ratings
  - Fuel moisture
  - Soil moisture
  - Stream flow
  - Smoke dispersion index
  - Fire behavior prediction
  - Other
- In which forms?

- Electronic files (digital, analog)
- Facsimile
- Voice
- Hardcopy graphics
- Other

- How do you now manipulate data?
  - Manual plotting
  - Map overlays
  - Manual entry via data terminal/workstation
  - Tabular

- Do you share data/information/secondary products?
  - With whom?
  - How communicated or transmitted?
  - How often? When?
  - In which form or forms?

How will the weather-sensitive information needs of this office evolve between now and 1992? Beyond 1992?

- Do you expect to access external systems (data libraries, etc) through WIMS interfaces? If so, which?

- What will you typically do during a work session? For how long?

- What other currently available "systems" would you like integrated in WIMS?
  - FBPS
  - NFMAS
  - NFDRS

  - FAP
  - FIREFAMILY

What new functions and features should WIMS provide?

- Local weather data/information processing
  - Automated data acquisition
  - Automated data reformatting
  - Automated data quality control
  - Automated data exchange with NFWDL
  - Automated data exchange with external data systems (e.g. AFOS, private databases)
- Interactive Features
  - Computer-assisted data quality review
  - Interactive data editing
  - Interactive model setup, submittal, retrieval
  - Interactive data retrieval from local storage
  - Data fusion (combinations of data fields)
- Local Data Analysis/Interpretation/Modeling
  - Graphical display capabilities
  - Imagery processing and pisplay
  - Compatibility with non-WIMS commercial software (spreadsheet applications, data base applications, graphics/plotting applications)
- Utilities
  - Do you need capabilities for graphical display? Plotting, overlaying, annotating, contouring, (e.g. terrain elevations, isotachs, isohyets, etc.), map backgrounds, satellite imagery

- Do you need Statistical Analysis Packages, e.g. SPSS?
- Report/Data Summary Generators?
- Data Base Software?
- Spreadsheets?
- Word Processing?
- Flow Charting?

How do you envision WIMS and its evolution?

- How should it be implemented? Like AFFIRMS? Differently?
- What technologies (e.g. workstations, graphics, storage media, etc) do you see impacting on WIMS?
- What new downstream applications (e.g., an integrated GIS?) do you see impacting on WIMS?
- How will planned research and development (e.g. Integrated Fire Behavior System) impact on WIMS?
- How would WIMS fit into your office's overall information management scheme?
- How might you envision a phased evolution of WIMS? What would it basically do/contain:
  - In the 1988-1992 time frame?
  - In the 1992-1995 time frame?
  - In the post-1995 time frame?
- Which non-Forest Service organizations should also benefit from WIMS?

3. SPECIAL QUESTIONS FOR FIRE WEATHER FORECASTERS

- How is the Forestry weather forecast function staffed?
- Which agencies/units/private sector are supported by this office?
- How many forestry weather forecasts are made daily? Weekly? Monthly?
- What kinds of forecasts?
  - General presuppression
  - Spot (prescribed burning and suppression)
  - Smoke management
  - Extended range planning (1-2, 3-5, 6-10 days, etc.)
  - Severe weather
  - Other (spraying, work planning, etc).
- How are the forecasts communicated?
  - Routine, scheduled
  - Special
  - Emergency/severe
- How are requests for special forecasts received?
- Do you have access to AFFIRMS?
  - How many of your customers use AFFIRMS?
  - Do you have access to AFOS?
  - Have you been able to "interface" AFFIRMS and AFOS?
  - Which of the "forecaster support" features of AFFIRMS do you use?
  - Do you use offline "session preparation" features?

  - Do you use "command" files?
  - Do you use the message "post" feature?
  - What do you like least about AFFIRMS?
  - What do you like about AFFIRMS that should be incorporated into WIMS?
- If you use FWIS, please answer applicable questions in F. above.
- What problems do you have handling the forestry forecasting work load that a higher level of automation would relieve?
- If you had better mesoscale weather information from systems like ASOS, NEXRAD, AWIPS, would you be able to use it?

4. SPECIAL QUESTIONS FOR AFFIRMS USERS

- Who in the office conducts the AFFIRMS sessions?
  - What is his/her job title and grade?
  - What is his/her experience with ADP?
- Please describe in detail the routine uses of AFFIRMS.
  - What is the means of access (communications)?
  - How easy, convenient, reliable?
  - Do you have a hardcopy of a sample of each kind of session for our use?
  - How often are station catalogs maintained? Who is responsible?
  - Do you process weather data from your own unit? For a neighboring unit or cooperator?
  - Do you use offline "session preparation" features?

  - Do you use "command" files?
  - Do you use the message "post" feature?

- Which data/information, other than that produced in your AFFIRMS sessions, do you monitor via AFFIRMS?
- Which other units and cooperators use your unit's weather data?
- Which NWS Fire Weather Office services your unit?
- What limitations of AFFIRMS would you give highest priority to changing in WIMS?
- What AFFIRMS features should be incorporated in WIMS?
- What new features/capabilities would you want in WIMS that are not available in AFFIRMS?
- Is the cost of AFFIRMS reasonable? Too high?
- How do you rate AFFIRMS technical support?
- How much training have the AFFIRMS operators had? Has it been adequate?
- What cost management steps have you taken?

5. SPECIAL QUESTIONS FOR FWIS USERS

(Same Questions as for AFFIRMS Users Above)

6. SPECIAL QUESTIONS FOR MANAGEMENT ABOUT AFFIRMS

- In which ways do you provide programmatic support to AFFIRMS?
  - Financial
  - Developmental
  - Technology

- What other programs are you directly responsible for? How do they intersect with AFFIRMS?
- How important is AFFIRMS to you?
- What programs does AFFIRMS support? What should AFFIRMS support?
- What are the strengths (attractive features) of AFFIRMS
- What are its weaknesses (unattractive features)?
- Which parts of AFFIRMS should be improved upon? Which parts can´t be?
- How do your users respond to AFFIRMS?
- What are the major cost drivers for AFFIRMS use?
  - Communications costs
  - Manpower costs
- For your uses (needs), is the cost of AFFIRMS reasonable? Too high?

7. QUESTIONS FOR NON-CURRENT USERS OF AUTOMATED WEATHER INFORMATION

- If you were using an automated system, who in this office would operate it?
  - Staff title or position
  - Level of ADP/computer training/experience
- Why haven´t you subscribed to AFFIRMS?
  - High costs
  - Not using the NFDRS
  - Lack of facilities (terminals)
  - Alternative, in-house capability

  - Reluctance to automate
  - Data not saved/archived
  - Other

- Do you process agency-originated weather data?
- Is it saved (archived) on paper or electronically? How long is it retained? If you do use it, what for? If you dispose of it, when (how often) and how?
- What features must WIMS have that would make you consider subscribing to the service?
- What are you willing to pay for a WIMS with the features you have listed?

APPENDIX C

USER NEEDS CONDENSED FROM INTERVIEW RECORDS

Subappendices C1 - C10 which follow present the edited users needs, organized by activity group

APPENDIX C1: GENERAL SYSTEM NEEDS

The following are the WIMS general system needs as collected from interviewees and edited to eliminate: (a) a great deal of duplication in the needs stated by different agencies; (b) stated ´system´ needs that more properly belong to a specific Forest Service activity area; (c) stated needs that are highly specific to a given user, and (d) stated needs that will be impossible to fulfill in the foreseeable future.

WIMS should include the following general system capabilities:

- Acquire and manage weather data according to uniform meteorological data standards (WMO and NWS).
- Accommodate a wide variety of dataset temporal and spatial resolution.
- Provide a robust data quality assurance facility, with automatic data screening/error flagging of RAWS, manual station and other data inputs.
- Provide standard data analysis techniques.
- Provide simple graphical displays of tabular/array data, e.g. map formats; x-y scatterplots; trends and regressions; histograms; bar/pie charts; with arbitrary overlaying.
- Allow the user to enter and edit data conveniently, e.g. to trend the previous data; to group stations and apply the same change or displacement; to enter forecast in relative or absolute units; to calculate moments, max/mins, cumulative values for arbitrarily-specific groups of stations.
- Be able to transform among standard meteorological units, e.g to dewpoint temperatures

from relative humidity or wetbulb temperatures; and handle both English and metric units.

- Allow user to build command files; macros; command line interpreters; pull-down menus; windows.
- Allow user-specified alternative display/ hardcopy options.
- Provide easy ingest of data with online editing capabilities, from both automatic and manual sources, including ´dumb´ terminal input.
- Support data/graphics/product acquisition from commercial forecasting/weather products services.
- Retain and provide interactive access to the previous 60 days worth of observed and forecast NFDRS indices, components, and input weather data.
- Allow user to flag a subset of files for automatic permanent archival.
- Permanently archive fire/forestry weather data.
- Allow users to customize their tabular displays, much the way in which AFFIRMS now does.
- Provide capability to exchange information with individual sites where data is managed on local, standalone PC/hard disk systems.
- Provide simple routines for data storage/ retrieval.
- Be able to run ´bundled´ fire/behavior/fire danger rating software, e.g., NFDRS, BEHAVE, FIREFAMILY, RXBURN, RXWEATHER, and forthcoming programs like WINDOW.
- Permit easy download of datafiles to the workstation environment from the NFWDL and

other external data libraries (e.g. SCS SNOTEL, USGS Streamgage System, etc.).

- Be available a minimum of 22 hours/day, 365 days/year.
- Have flexible provisions to disseminate forecasts to Forest Service and non-networked users.
- Provide standard user interface functions.
- Be fully integrated with the Forest Service GIS.
- Provide programmable automatic access to download RAWS data from GOES-East.
- Provide central management of data.
- Have the ability to ingest some project-specific data from a standard IBM floppy, or through telephone modems. WIMS needs modem ports.
- Provide a RAWS station directory capability, to retrieve station siting and service record.
- Be able to identify all routine-reporting Forestry/fire-net stations within an operator-specified radial distance from a given location.
- Offer standard statistical packages.
- Provide access to spreadsheet and database management packages.
- Support color graphics hardcopy, and provide ability to transmit color graphics electronically (e.g., to transmit National Severity maps from NIFCC to Forest Service/WO).
- Distribute digital ALDS data in real-time to Forest Service users.
- Support laser printer graphics.

- Support geographically-referenced color displays.
- Provide data fusion capabilities for fire suppression decisions.
- Offer automatic dialup access into TELENET and other commercial packet switching networks, e.g., COMPUSERVE (Department of Interior agencies); PRIMENET (Southern California agencies); TELEMAIL (State agencies, Forester's offices); DIALCOMP (Canada).
- Offer automatic protocols for weather data retrieval, reformatting, storing, e.g., from BLM/IAMS, NPS (Microvax/DEC), etc.
- Provide an 'active system' alert function to receive alarms originated by a local automated weather observing station, as well as warnings and other bulletins from the NWS, River Forecast Centers, others.
- Provide an 'active system' update function to update data bases as data/products become available.
- Provide a user assistance system with online tutorials and other guidance to direct the user to the appropriate application.
- Offer ability to create full field-addressable onscreen data query forms and field-addressable templates to generate request runstreams and manual data entry.
- Provide a Standard Query Language.
- Provide graphics display tools to contour data fields, display and interpolate wind fields with wind barbs, create 2-d and 3-d terrain representations.
- Provide local storage for user-specific program code and data in workstation.
- Provide a user-friendly, uniform gateway to other systems like IAMS.

- Provide access to NWS AFOS (and eventually AWIPS) weather data and products.
- Provide a utility to transmit easily to designated groups of users with various inclusive "ALL send" commands.
- Provide electronic mailbox/alert functions.

APPENDIX C2: FIRE AND AVIATION MANAGEMENT NEEDS

The following are the weather information management needs collected from Fire and Aviation Management specialists of the various agencies, and edited to eliminate: (a) a great deal of duplication in the needs stated by different agencies; (b) stated ´system´ needs that more properly belong as General System Needs or to another Activity area; (c) stated needs that are highly specific to a given user; and (d) stated needs that will be impossible to fulfill in the foreseeable future.

To meet Fire and Aviation Management requirements, WIMS should provide the following capabilities:

- National-scale shared datafiles of observed and forecast fire weather and fire danger ratings (NFDRS).
- Retention of the national, interagency features of AFFIRMS.
- Convenient AFFIRMS-like options for entering and retrieving fire weather observations and NFDRS indices.
- Local processing capabilities, e.g., NFDRS, FIREFAMILY, BEHAVE, etc.
- The option to recalculate/update the NFDRS indices with corrected weather.
- Online storage/retrieval of current season NFDRS values.
- Automated data ingest/processing/update/archive of fire and forestry weather from RAWS, manual stations, other sources.
- Temporary onsite retention and interactive access to 30 to 60 days of weather data and NFDRS indices and components from permanent and seasonal RAWS stations (local and nearby stations).

- Easy access to the FCCC NFWDL and NFODL, to update local database.
- Interactive access to BLM IAMS RAWS diurnal (24 hourly) data, archives and information.
- Ability to ingest radio-linked RAWS data.
- Data quality control/assurance facilities, with automatic data screening/error flagging of RAWS and manual data inputs.
- Access to fire weather narratives from all fire weather forecasters (NWS and private sector) nationwide.
- GIS format to encode fire management zones ´polygons´.
- Access to data files for areal fuels, areal fuel moisture, soil moisture and vegetation growth stage and moisture content.
- Ability to access/create digitized slope, aspect, elevation data, and topographic contours
- Ability to create hardcopy charts of relative BI, relative seasonal ERC, 1000-hour timelag fuel moisture, by fire management ´polygon´ zone for a Region (regional analogue of National Fire Severity Projection charts).
- Access to NOAA Climate Analysis Center
- Access to NWS data and information:

  NWS Family of Services products, forecasts, and graphics.

  NWS cooperative observer data.

  Hourly FAA and NWS surface observations and forecasts.

  NMC extended range forecasts products (3-5, 6-10, and 30 days), and ability to archive daily NWS forecasts.

  NWS severe weather, wind and flood warnings.

NWS 24h and 48h surface and upper air (500 mb) progs.

- Capability to compute and display the ´500mb positive anomaly´ field.
- Capability to overlay 500mb winds, heights, temperatures, precipitation.
- Access to 10-15 day forecasts from European Center for Medium Range Forecasts.
- Ability to create graphics maps, time/space plots of weather information and parameters (maps such as produced by FWIS and AFOS).
- Access at the forest level to regional 3-day weather outlooks.
- Site-specific fire weather forecasts for prescribed burning conditions.
- Access to GOES visible and IR cloud, water vapor satellite imagery, (DIFAX as a minimum).
- (Potential future satellite data needs):

  Multichannel visible and infrared data.

  Multichannel microwave radiometer data.

  Surface moisture and temperature.

  Vegetation classification.
- Ability to display synoptic/regional/mesoscale weather maps with zooming and animation.
- Access to NEXRAD-type precipitation real time data products and tools to calculate areal distribution of precipitation in real time.
- Data/information for fog formation forecasts and means of detecting fog.
- Means of monitoring progress and strength of sea breeze fronts.
- Low level wind profiles.

- Site-representative meteorological information for smoke management: mixing height, mixed layer transport wind, dispersion indices, stability information.
- Access to smoke dispersion models and an automated smoke behavior prediction system for smoke management.
- Daily forecasts to support fire danger rating program.
- One to three day forecasts for work planning.
- Means of archiving forestry/fire-net observations.
- Access to prescription development software (RXWEATHER, RXBURN, etc.).
- Vegetation growth stage (greenness).
- Efficient access to climatology data files and climatological monthly summaries (including standard fire weather and upper air data sets) from NOAA/NCDC, USDA/NFWDL, State Climatologist Offices, others).
- Probabilistic decision aids, conditional probability forecasts.
- PC versions of standard FCCC fire programs (FIREFAMILY, etc.).
- Graphic (and hard copy) weather charts/maps at incident command sites.
- Automated submittal of formatted spot forecasts.
- Centralized database management system with easy download capability.
- Statistical tools to correlate ALDS data with precipitation and fire occurrences.
- Built-in procedures for prioritizing, selecting data for permanent data retention.
- Onsite weather support for incident management (NWS ATMU).

- Representative wind field data to drive diagnostic wind field models.

APPENDIX C3: AIR RESOURCE MANAGEMENT NEEDS

The following are the Air Resource Management Research and Operational Needs for weather information management.

WIMS should include the following capabilities:

- Ability to access stored wind and temperature fields, and couple efficiently to TAPAS (wind field generation model) and PUFF transport-dispersion model.
- Three-dimensional graphics for representation of topographic fields.
- Ability to store/access data, create/interrogate static topography files, from USGS digital topographic tapes.
- Ability to process special sounding data.
- Ability to compute equivalent Turner stability class/index from RAWS data.
- Access to short-term average (10 min) wind speed, wind direction from programmable RAWS.
- Access to cloud cover data from nearest representative NWS station.
- A system utility to format RAWS data as a surrogate for NCDC TDF14 tapes, for use with conventional EPA air quality models.
- Interactive jobstream creation/access to the EPA UNAMAP air quality and special-purpose models.
- Access to satellite visible/IR cloud cover and IR surface temperatures

APPENDIX C4: WATERSHED AND HYDROLOGY NEEDS

The following are the Watershed and Hydrology Needs for weather information management needs, edited to eliminate those needs identified elsewhere.

WIMS should include the following capabilities:

- Access to SCS, USGS, RFC streamgage data and archives.
- Daily access to SCS SNOTEL automatic network for the following data fields: T, Ws, Wd, precipitation, snowpack (depth and equiv. water), soil temperature at 20", air temp. Data is needed every 15 minutes.
- Monthly access to SCS manual snowpack station database.
- Climatological monthly and annual precipitation databases (compiled by U. Montana).
- Quantitative Precipitation Forecasts, via localized MOS.
- Storm intensity on hourly, 15 minute periods, with forest-scale coverage.
- Precipitation intensity (stochastic variability), with 5-minute to 30-minute changes.
- Monthly precipitation probability distributions to drive snowmelt models.
- Access to U.S. Army Corps of Engineers Hydrological Engineering Center model; for erosion and sedimentation analyses (WEPP erosion program).
- Tutorial to assist users to locate meteorological and climatic data/information.
- Future needs: ability to estimate equivalent water in watershed, from microwave and visible satellite data.

APPENDIX C5: RANGE MANAGEMENT NEEDS

The following are the Range Management needs for weather information management, edited to eliminate those needs identified elsewhere.

WIMS should include the following capabilities:

- Thirty day and seasonal temperature and rainfall outlooks, to drive (yet to be developed) forage condition prediction models.
- Fourteen day temperature and rainfall forecasts, for managing permittee livestock.
- Cumulative amounts of recent (several weeks) and seasonal precipitation.
- Ability to compute evapotranspiration, from precipitation, temperature, relative humidity, winds.
- Broad-scale maps of climatic weather normals/extremes for range rehabilitation and soil moisture storage capacity.
- Maximum-minimum air and soil temperatures to drive vegetation development models.

APPENDIX C6: RECREATION NEEDS

The following are the Recreation needs for weather information management, edited to eliminate those needs already identified elsewhere.

WIMS should include the following capabilities:

- ´Active system´ capabilities for delivery of local-scale severe weather, flood and high wind warnings.
- ´Active system´ capabilities for relaying weather and avalanche forecasts and warnings.
- One-day to five-day forecasts, by zones, within the state.
- Weather predictors for avalanche potential: weight, density of snowpack; winter season history of precipitation, temperature, winds.
- Customized area forecasts delivered by public-access terminal message service for recreational users, e.g., weather forecasts, ALDS lightning data to alert users of hiking trails.
- Systematic way to save weather information for avalanche research.
- Historical information on sky condition and visibility.
- Access to California Water Resources Board historical weather data telemetered from wilderness areas.

APPENDIX C7: TIMBER MANAGEMENT NEEDS

The following are the Timber Management needs for weather information management, edited to eliminate unrealistic needs (e.g. the request for accurate five-year climatic outlooks, to adjust nursery schedules), and those needs identified elsewhere.

WIMS should include the following capabilities:

- Information on area snow pack (extent and water content).
- Local climatology of boundary layer winds, precipitation, density, altitude, for helicopter and lighter-than-air logging operations.
- Diurnal, site specific 24-hour forecasts of wind speed, relative humidity, and free air temperature, for planting.
- Access to recent past weather for planting survival post analysis and evaluation of requests for contract term adjustments.
- Precipitation climatology combined with soil moisture information, to determine feasibility of planting.
- Short range forecast for predicting pollen flight in seed orchards.
- Three-day local forecasts, to start/stop planting contractor operations.
- Estimates of site specific extreme winds for assessing windthrow risk.
- Local acquisition/retention of nursery weather data from Omnidata data units: photosynthetically active radiation, total radiation, soil moisture, temperature, relative humidity, precipitation, wind speed, and direction.

- Ability to ingest data from Omnidata data storage packs and enter into spreadsheet package.
- Ability to interface with local nursery Bernoulli box units for data storage.
- Ability to track cumulative totals of chilling degree days, growth degree days, to relate the weather to the growth phase of the seedlings.

APPENDIX C8: PEST MANAGEMENT NEEDS

The following are the identified Pest Management Needs for weather information management, edited to eliminate needs already identified elsewhere.

WIMS should include the following capabilities:

- High resolution degree-day predictions corrected for altitude and aspect, for predicting insect/vegetation stage.
- Short range inflight weather and site specific dispersion conditions for aerial spraying of pesticides.
- Access to long term climatology for developing models relating weather to insect population dynamics.
- High resolution temperature data (satellite) for predicting insect and vegetation development stage.
- Satellite observations of vegetation "greenness".

APPENDIX C9: ENGINEERING NEEDS

The following are the Engineering needs for weather information management, edited to eliminate those needs identified elsewhere.

WIMS should include the following capabilities:

- Project-scale forecasts for work planning, road construction, e.g., 1-2 day forecasts of rain and temperature, for concrete placement and surface hardening.
- Access to unit hydrograph models for runoff prediction.
- Spatial precipitation distribution and soil moisture for assessing trafficability of roads and off road areas.
- Wind and heavy precipitation warnings.
- Climatological forest-level cloud cover (for air reconnaissance planning).
- Real-time cloud cover for aircraft go/no go.
- Lightning strike probabilities, for effects on communications/computers.
- Climatological precipitation data representative of local site, elevation, exposure.
- Ability to create special precipitation climatology products, e.g: (a) expected annual precipitation (for road regrading work load projections); (b) number of days/month with precip greater than 0.1" (to design logging roads, plan road servicing maintenance programs); (c) number and duration of freeze/thaw cycles per month (to predict lifetime of soil stabilizers); (d) number of degree days of road surface curing (days over 40F).
- Reliable estimates of temperature lapse rate in elevated terrain and expected changes.

- Capability to automatically alert on the number of freeze/thaws per month and record the duration of thaws.

APPENDIX C10: FISHERIES AND WILDLIFE NEEDS

The following are the identified Fisheries and Wildlife Needs for weather information management, edited to eliminate needs already identified elsewhere.

WIMS should include the following capabilities:

- Forecasts of warm rain-on-snow events, to take real-time action to preserve some fisheries stock.
- Basin/subbasin scale cumulative precipitation (seasonal to yearly) for predicting effects of harvested forest areas on fisheries (siltation).
- Predictions of stream flow levels, focusing on spawning habitats.

APPENDIX D

FORESTRY WEATHER INFORMATION SYSTEM (FWIS)

The WIMS needs assessment team talked to a few people knowledgeable about FWIS. The information we received is sumamrized in the following paragraphs.

- Users were more interested in the diurnal, topographic- and local-scale than in the '24-hour worst case', synoptic- and meso-scale character of weather.
- The ready availability of current NWS and FAA surface weather observations was a much-lauded feature. There was considerable enthusiasm for using NWS and FAA surface weather observations to supplement or replace forestry-net data.
- There was a great deal of enthusiasm for 'gridded weather' presentations since they allowed the users to follow transitory, synoptic-scale weather systems.
- The FWIS 'gridding' and 'interpolation' routines masked meso-scale weather features such as sea breeze fronts, wind-shear lines, and thunderstorms. Users had little or no idea about the correctness of the 'gridding' and 'interpolation' routines.
- The regional 'orientation' and scope of FWIS gave the users the sense that they could influence the direction of further System development. The responsiveness of FWIS system management to request for additions and changes to System features was a big plus in the opinion of the users.
- Interviewees embraced the FWIS feature that enabled the System to generate forecasts without fire-weather forecaster intervention.

- The 'smoke behavior/dispersion" routine had seldom been used, though interviewees cited 'smoke behavior' modeling as a high priority need for WIMS.
- The service's availability and reliability was poor (outdated hardware and too-few ports).
- The costs were too high (once the Forest Service stopped underwriting the cost).

The Georgia Forestry Commission (GFC) is running an updated (but stripped-down) version of FWIS on a GFC computer and making the information available (via voice radio) to the forestry community in Georgia. The data the Georgia Weather System requires is acquired from a commercial source. Like FWIS, the GFC Weather System can automatically generate forecasts using NMC MOS products. The GFC Weather System operates independently of the NWS Fire Weather Service.

GLOSSARY OF ACRONYMS

AFFIRMS	Administrative Forest Fire Information Retrieval and Management System
AFOS	Automation of Field Observation Services
ALDS	Automated Lightning Detection System
AWIPS	Advanced Weather Interactive Processing System
BI	Burning Index
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
CFES	California Fire Economic Simulator
CAC	NOAA Climate Analysis Center
EPA	Environmental Protection Agency
ERC	Energy Release Component
F&WS	Fish and Wildlife Service
FBPS	Fire Behavior Prediction System
FCCC	Fort Collins Computer Center
FS	USDA Forest Service
FS/WO	USDA Forest Service / Washington Office
FWIS	Forestry Weather Information System
GFC	Georgia Forestry Commission
GIS	Geographic Information System
GOES	Geostationary Operational Environmental Satellite
IAMS	Initial Attack Management System
MOS	Model Output Statistics

NCDC	National Climatic Data Center
NESDIS	National Environmental Satellite Data Information Service
NEXRAD	Next Generation Advanced Weather Radar
NFDRS	National Fire Danger Rating Systme
NFMAS	National Fire Management Analysis System
NFODL	National Fire Occurrence Data Library
NFWDL	National Fire Weather Data Library
NIFCC	National Interagency Fire Coordination Center
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NWS	National Weather Service
PDN	Public Data Network
RAWS	Remote Automatic Weather Station
RFC	River Forecast Center
SCS	USDA Soil Conservation Service
USGS	U.S. Geological Survey
WIMS	Weather Information Management System